Conduct of the Persian Gulf War

Final Report to Congress

Pursuant to
Title V of The Persian Gulf Conflict Supplemental Authorization and Personnel Benefits Act of 1991 (Public Law 102-25)

APPENDIX T
PERFORMANCE OF SELECTED WEAPON SYSTEMS

April 1992

PREFACE

The final report to Congress on the conduct of hostilities in the Persian Gulf (pursuant to the requirements of Title V of the Persian Gulf Supplemental and Personnel Benefits Act of 1991) is divided into three volumes. The first volume deals with the nature of Iraqi forces, Operation Desert Shield, the Maritime Interception Operations and Operation Desert Storm. The second and third volumes contain appendices dealing with specific issues.

Discussion in volume I focuses on how the threat in the Persian Gulf developed and how the United States and its Coalition partners responded to that threat at the strategic, operational, and tactical levels. The narrative is chronological to the extent possible. In this sense, it touches on issues such as logistics, intelligence, deployment, the law of armed conflict, and mobilization, among others, only as those issues have a bearing on the overall chronicle.

This is not to suggest that other issues are not important. In fact, examination of these issues is of great substantive value to future security plans and programs. To provide ready access to this information, discussions of specific issues have been structured into appendices and collected in Volumes II and III. The intent is to provide as much detail as possible about a specific issue in one location. For all intents and purposes, the appendices are independent documents and with enough background to let the reader concerned with a particular area read the appropriate appendix and forego other parts of the report. Where cross-referencing or overlapping occurs, it is to achieve that objective.

The content of all volumes of this report is the result of extensive research conducted through review of original source documents (such as orders, plans, estimates, and appraisals); information from the Office of the Secretary of Defense, Joint Staff, the United States Central Command, other unified and specified commands, component commands, and the military Services; and, in-depth interviews with many senior officers and policy makers involved in Operations Desert Shield and Desert Storm. Research to determine what lessons ought to be taken from the crisis began before the conflict ended. Throughout, officials at all levels willingly provided information. However, this conflict was exceptionally well documented compared with previous crises. Many data points remain in raw form and information on some aspects of the campaigns remains uncollated and unevaluated. The volume of available documents, perhaps in the millions of pages, will provide researchers with data for a number of years. Therefore, while the depictions, conclusions, and evaluations presented in this report are based on a thorough examination of the existing evidence, they are subject to modification as additional research makes more information available.

APPENDIX T: PERFORMANCE OF SELECTED WEAPON SYSTEMS

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APPENDIX T

PERFORMANCE OF SELECTED WEAPON SYSTEMS

"It is absolutely essential that we review the performance of our people, platforms, weapons, and tactics while our memories are fresh. We want to find out what worked well and what didn't work so well."

Admiral F. B. Kelso, II, Chief of Naval Operations

Technology and sophisticated weapon systems had an enormous effect on the conduct and the outcome of the Persian Gulf conflict. While some equipment, weapons and munitions had been in the inventory for some time, others were new. In fact, some were still in the developmental stages when the war began and were fielded prior to completion of normal test and evaluation schedules. A few systems had been used in combat prior to the Operation Desert Storm, but many were not combat proven. Therefore, an evaluation of the employment and performance of military equipment, weapons and munitions takes on a special significance, and requires a thorough, systematic analysis of all available data.

Weapon systems performance was influenced by a number of factors, including weather conditions, the nature of desert terrain, employment criteria (e.g., rules of engagement, altitude restrictions, attempts to minimize collateral damage), munitions capabilities, and Iraqi capabilities and tactics. These factors should be considered when evaluating the performance of specific systems.

CAVEATS

Scope

This appendix provides a broad overview of the employment and performance of selected weapon systems and is divided into five sections: aircraft systems, ground systems, munitions, naval systems, and space systems. It is not practicable to discuss in this report all the different systems and forces which contributed to the Coalition's overwhelming victory in Operation Desert Storm. The systems discussed in this appendix were by no means the only systems to play a role in this conflict. Other systems also made contributions to the war effort.

For security reasons, the shortcomings of many weapon systems are classified; therefore, some shortcomings are not listed in the observations sections of this unclassified report.

System Performance and Mission Accomplishment

The accomplishments and shortcomings of individual weapon systems should be considered in the context in which the systems were employed, taking into account the missions assigned to each system. A number of systems were used in more than one mission area, some systems were used in roles other than those for which they originally were designed, and many systems were used together to accomplish specific mission objectives. This appendix should be considered in conjunction with Chapters III through VIII of this report, which discuss the conduct of Operations Desert Shield and Desert Storm, and assess mission area accomplishment.

Data Limitations and Biases

Several limitations and biases in the data on which these assessments were based should be considered when reviewing the following analyses. Much of the data collected remain uncompiled and unanalyzed. The large number of air warfare missions flown, for example, makes data collection a time-consuming task. Data compilation and analysis is likely to require several years. What is presented here is what is currently available, a fraction of what may ultimately be accumulated. Conclusions drawn from the data available now might be changed by data that becomes available in later studies.

Some important data were not collected. Comprehensive battle damage assessment (BDA) data do not exist. It is difficult to assess weapon effectiveness without detailed data on what targets were damaged, to what extent, and by which systems. This assessment is not possible without on-the-ground inspection.

Even where BDA is available, it can be difficult to associate damage with a specific weapon. Many targets were hit with several weapons of the same type or with several different types of weapons or both. In most cases, it is impossible to be sure which weapons did what damage. Effectiveness of the individual weapons cannot always be determined.

The other bias inherent in the data is that data are better for the more advanced systems such as the F-117. Many of the newer, technologically sophisticated systems have on-board recording devices which make the data collection task significantly easier and provide more accurate data. More data are available earlier for these systems than for their less advanced (but perhaps equally effective) counterparts. It may be worthwhile to include mission recording devices on future weapon systems.

APPENDIX T. Performance of Selected Weapon Systems

AIRCRAFT SYSTEMS

A-6E INTRUDER ATTACK AIRCRAFT

Mission

The A-6 Intruder is a carrier- and land-based, all-weather attack aircraft able to provide accurate weapon delivery day or night. The A-6 contains an all-weather ground mapping radar, a forward looking infrared (FLIR), and a self-contained laser designator for the accurate delivery of laser-guided weapons. The A-6 also can provide close air support (CAS) to ground forces in all weather conditions using a radar beacon to identify friendly forces and obtain targeting information.

System Data

Prime Contractor: Grumman Aerospace Corp.
Crew: One pilot; one bombardier-navigator
Initial Operational Capability: 1965
US Inventory: 350
Length: 55 feet
Wingspan: 53 feet
Weight: 60,400 maximum takeoff
Speed: 560 knots at sea level
Range: 672 miles (combat radius)
Propulsion: Two Pratt and Whitney J-52 P-8B turbojet engines
Armament: Able to carry conventional munitions including gravity and laser-guided bombs (LGB), Harpoon, High Speed Anti-radiation Missile (HARM), and Standoff Land Attack Missile (SLAM)

Employment

During Operation Desert Storm, the A-6 operated extensively during darkness, inclement weather, and when target areas were obscured by smoke from oil well fires. Although originally designed over 30 years ago, the A-6 has undergone many system improvements. Two squadrons that participated in Operation Desert Storm were equipped with the latest version of the A-6, the A-6E System Weapons Improvement Program (SWIP), an upgrade that includes improved avionics, reliability and maintainability upgrades, and weapon system upgrades that allow use of SLAM, Maverick, HARM, and the Harpoon anti-ship missile to its full capability. These units participated in the first operational SLAM firings. During the war, the A-6 was used in the following mission areas:

- Day-, night-, and all-weather strikes using precision-guided and conventional weapons against point and area targets in support of strategic bombing and battlefield interdiction.
- Close air support (CAS) in direct support of Coalition ground forces.
- Antisurface warfare using missiles and conventional weapons against Iraqi naval units in day- night-, and all-weather conditions.
- Strike support suppression of enemy air defenses (SEAD), including use of HARMs and delivery of Tactical Air-Launched Decoys (TALD).
- Deep strike launch of the new SLAM.

Performance

Overland strike packages were launched from two battle forces; one in the Red Sea, the other in the Persian Gulf. Ninety-five Navy A-6s were used, flying 4,045 sorties. The Red Sea battle force averaged 6.4 strike aircraft per strike while the Arabian Gulf battle force averaged 3.2 strike aircraft per strike. A-6s were used for attacks on high value targets, Iraqi ground forces, Iraqi naval units, artillery, logistics sites, and armor concentrations. With the exception of four strikes early in the war, all Navy ordnance was delivered from medium to high altitude (above 10,000 feet). Typical loads included eight-12 MK-82s, eight-12 MK-20s, six MK 83s, two to four MK 84s, two MK 83 LGBs, or two MK 84 LGBs. Weapons normally were delivered in level flight or in a shallow dive. Target acquisition normally was done using the radar to cue the FLIR. Mission reports indicate about one third of the strike missions required radar deliveries because weather, smoke, or haze prevented FLIR use. Self-protection chaff and flares were used routinely; because of the limited quantity of chaff and flares that can be carried, aircrews tended to husband chaff during the approach to the target to have enough for use in the target area and during departure. A-6s also were used to support strike packages in SEAD by launching TALD or, in the case of the units with the A-6 SWIP, by using HARMs to suppress enemy threat radar systems.

Twenty Marine Corps (USMC) A-6s, flying 854 sorties from land bases, attacked strategic targets (Scud repair/assembly buildings) and interdiction targets (bridges, railroad yards, and ammunition storage areas). At the beginning of the war, A-6s were formed into mixed strike packages (four A-6s and eight F/A-18 bombers with eight F/A-18 fighter suppression escorts, and two EA-6Bs). As the war progressed and air defenses were suppressed, strike packages were reduced to eight bombers and two EA-6Bs. Normal USMC A-6 bomb load was four MK-84 unguided bombs. USMC A-6s also carried LGBs. Delivery tactics were the same as for Navy A-6s. Almost all USMC A-6 missions were flown at night.

Five A-6 aircraft were lost or damaged in combat; two early in the war during low-altitude attacks.

Because of its age, the A-6 required more maintenance manhours per flight hour.

The mission data recorder was unreliable in obtaining necessary battle damage assessment (BDA) information.

OBSERVATIONS

Accomplishments

- Navy and USMC A-6s flew more than 4,700 sorties in support of Operation Desert Storm.
- The A-6 is credited with the first successful combat use of SLAM.
- The A-6 played a key role in the early SEAD effort with HARM and TALD delivery capability.
- A-6s were used extensively at night use because of its all-weather, night-attack capability. The A-6's combination of radar, FLIR, and laser guidance and ranging capability allowed the effective delivery of PGMs and unguided ordnance.

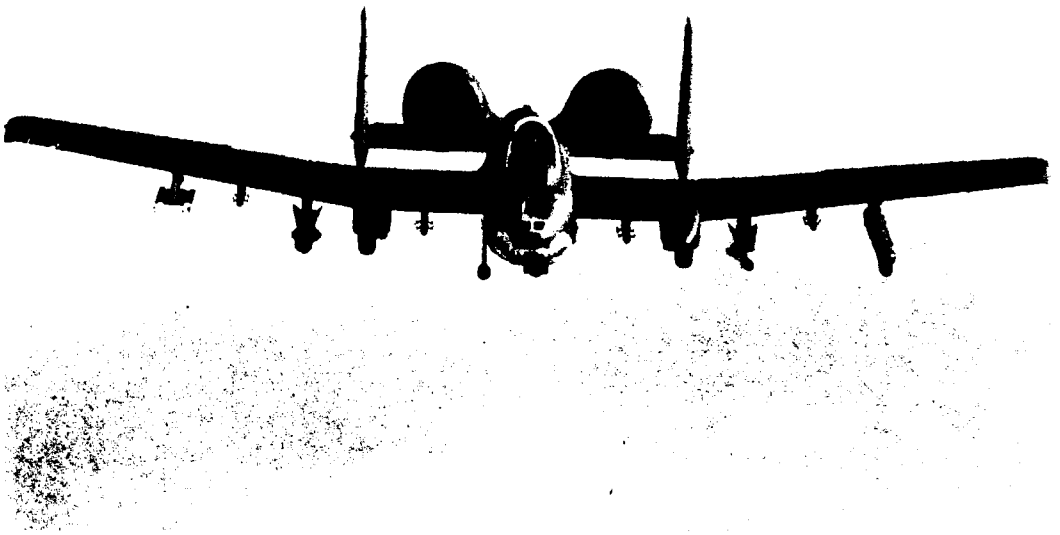
Shortcoming

- The A-6 is an old aircraft and is becoming increasingly more difficult to maintain.
- The A-6's mission data recorder is ineffective for accurate BDA.

Issues

- Improving the on-board navigation system will increase system effectiveness and responsiveness. (The NAVSTAR Global Positioning System currently offers the most promising alternative.)
- Navy plans to operate the A-6 until it is replaced by a new aircraft (designated AX), starting in approximately 2005.

A-10 THUNDERBOLT II ATTACK AIRCRAFT



Mission

The A-10, the Air Force's primary close air support (CAS) aircraft, can strike targets, ranging from armored vehicles to artillery, both near friendly ground forces and in the enemy's second echelon. The OA-10 provides airborne control of tactical air assets that perform CAS missions. The OA-10 locates and identifies targets and then directs aircraft to the targets. The OA-10 and the A-10 are the same airframe.

System Data

Prime Contractor: Fairchild Republic Co.
Crew: One pilot
Initial Operational Capability: 1976
US Inventory: 565
Length: 53.3 ft
Wingspan: 57.5 ft
Weight: 51,000 lbs (maximum takeoff)
Speed: 350 knots
Range: 250 miles (9,500 lbs of ordnance and 1.8 hours of loiter time)
Propulsion: Two General Electric TF34-GE-100 turbofan engines
Armament: Internal 30 mm gatling gun (1,100 rounds high explosive or armor piercing ammunition), 11 external points for carrying most conventional munitions

Employment

A total of 136 A-10s and 12 OA-10s deployed to Saudi Arabia during Operation Desert Shield. All aircraft were based at King Fahd International Airport and used King Kahlid Military City (KKMC) as a forward operating location. This concept let the aircraft return to KKMC between missions, reducing transit time to the Kuwait Theater of Operation and minimized air refuelings.

The aircraft flew 8,077 combat sorties, of which fewer than 1,000 flights supported CAS missions. In addition to traditional missions, A-10s were used for suppression of enemy air defenses and Scud hunting. A-10s sometimes were used during the day to search for and destroy mobile Scud missile systems, and to complete destruction of surface-to-air missile (SAM) sites after those targets had been attacked by other aircraft.

Most sorties were conducted during daylight, but A-10s did perform limited night operations. One of the six squadrons deployed became a dedicated night-attack squadron and trained extensively in night operations during Operation Desert Shield.

Performance

Operating with a reduced threat of radar-guided SAMs, the A-10 was able to engage an average of four to five targets a sortie. A-10s fired 4,801 Maverick missiles, more than 90 percent of those delivered during the war. A-10 air interdiction (AI) operations can be characterized as innovative employment in non-traditional roles. The A-10s long loiter and large payload capability made it ideal for missions such as day Scud hunting and combat search and rescue (CSAR) escort. During the rescue of an F-14 pilot, A-10s escorting a Special Operations Forces (SOF) CSAR helicopter destroyed an Iraqi radio intercept truck that was searching for the pilot. The A-10 also was credited with two air-to-air helicopter kills. The A-10 acnieved an outstanding 87.7 percent mission capable (MC) rate.

While its slower speed and long loiter time over the battlefield made it susceptible to enemy fire, the A-10's small vulnerable area allowed many battle-damaged aircraft to return safely to base. Moreover, 10 of the 15 A-10s damaged were returned to action within a day and all but one flew again during the war. Nevertheless, the aircraft suffered six combat losses.

The A-10 is susceptible to threats due to the longer exposure time caused by insufficient engine thrust which limits rate-of-climb, acceleration and maneuver, and cruising speed.

The A-10's night-attack capability is limited to the use of the Maverick seeker or flares. Neither is viable without a mid-to-high altitude sanctuary.

OBSERVATIONS

Accomplishments

- The A-10 performed well in a variety of missions and was particularly effective in AI and CAS roles.
- The A-10 fired 4,801 Maverick missiles with a 94 percent reliability rate.
- The A-10 achieved an 87.7 percent MC rate.

Shortcomings

- The A-10's slow speed and limited maneuverability make it susceptible to antiaircraft artillery and SAMs.
- The A-10 has limited night-attack capability.

Issue

- While the survivability features of the A-10 are good, future aircraft should be designed with higher performance to reduce susceptibility to damage while maintaining low vulnerability.

AH-1 COBRA ATTACK HELICOPTER

Mission

The AH-1's primary mission is to provide close-in fire support and fire support coordination under day, night, and adverse weather conditions. Additional missions include armed escort for assault transport helicopters, point target; and anti-armor operations; anti-helicopter operations; point and limited area defense against threat fixed wing aircraft; and reconnaissance.

System Data

Prime Contractor: Bell Helicopter Textron
Crew: Two
Initial Operational Capability (IOC): AH-1W/1986, AH-1T/1978, AH-1J/1969
US Inventory: 78 AH-1W, 7 AH-1T, 36 AH-1J
Length: 58 ft
Rotor diameter: 48 ft
Maximum Gross Weight: 14,750 lbs (AH-1W)
Speed: 140 knots (cruise)
Range: 140 miles (combat radius)
Endurance: 2.5 hours
Armament: Tow, Hellfire, Sidewinder, and Sidearm missiles, 2.75" and 5" rockets, and 20-mm gun

Employment

The Marine Corps (USMC) deployed four of six active squadrons (50 AH-1Ws) and two reserve squadrons (26 AH-1Js) to support both ashore and afloat operations in Southwest Asia (SWA). In addition, three AH-1Ts were deployed aboard the *USS Nassau* (LHA 4) with the 26th Marine Expeditionary Unit. These helicopters provided close-in fire support and fire support coordination, conducted point target and anti-armor operations, and reconnaissance. USMC squadrons flew 8,278 hours. The Army deployed 145 AH-1Fs to SWA. Army units flew more than 10,000 hours conducting daylight armed reconnaissance and screening operations.

Performance

During anti-armor and armed reconnaissance missions, AH-1Ws reportedly destroyed 97 tanks, 104 armored personnel carriers and vehicles, 16 bunkers, and two antiaircraft artillery sites without a loss to enemy fire. Small detachments of two to four AH-1Ws routinely operated from remote forward area rearming points and refueling sites to provide quick reaction, close-in fire support. The AH-1W's weapon flexibility (i.e., dual TOW/Hellfire missile capability) was invaluable.

The AH-1Fs were useful in conducting daylight armed reconnaissance operations and security patrols. For example, two AH-1Fs used TOW missiles and 2.75 inch rockets to destroy light armored personnel carriers. AH-1Fs also used TOW missiles, 20-mm rounds, and 2.75 inch rockets to prevent an Iraqi Republican Guard convoy from crossing a causeway over the Euphrates River. The convoy's lead vehicle was destroyed by a TOW missile, which blocked the causeway.

Small and large scale group surrenders to AH-1Fs and AH-1Ws were common and often occurred after precision guided TOW or Hellfire missiles were fired at enemy armor or fortified positions. For example, a scout weapons team of OH-58s and AH-1Fs, providing security for a refueling operation, flew over Iraqi hardened positions and caused the Iraqi soldiers to surrender, according to after action reports from the 1st Infantry Division.

During Operation Desert Shield, the decision was made to deploy the 24 reserve AH-1Js to SWA. As a result of the continuing requirement to support contingency operations in the Mediterranean and the Pacific, the Marine Corps activated two Reserve AH-1J squadrons to augment and reinforce AH-1Ws in SWA. The 20-year old AH-1J Cobras were not capable of anti-armor or antiair operations, but provided combat escort and armed reconnaissance for helicopter assault operations. AH-1s lacked a night targeting system, which severely restricted night and adverse weather operations and the use of the Hellfire missile's superior stand-off capability. The lack of an onboard laser designator also was a deficiency. AH-1s did not have a sophisticated navigation system. Because the Global Positioning System (GPS) was essential for accurate navigation in the desert, AH-1Ws were fitted with an interim GPS system before Operation Desert Storm.

The SWA desert environment demanded an unprecedented level of preventive maintenance:

- Canopies required protective covers to minimize degradation from heat and blowing sand.
- Protective blade tape was applied to the leading edge of main rotor blades to prevent sand erosion.
- Despite increased frequency of engine washing, engine life was reduced due to turbine blade sand erosion.
- Because the AH-1W is designed to survive the harsh ocean environment, AH-1Ws successfully withstood the effects of the desert environment. Sealed compartments protected the aircraft's avionics and electronic systems from sand.

OBSERVATIONS

Accomplishment

- The AH-1's weapon flexibility was invaluable. AH-1s destroyed tanks, armored personnel carriers and vehicles, bunkers, and anti-aircraft artillery sites with TOW and Hellfire missiles, rockets and guns.

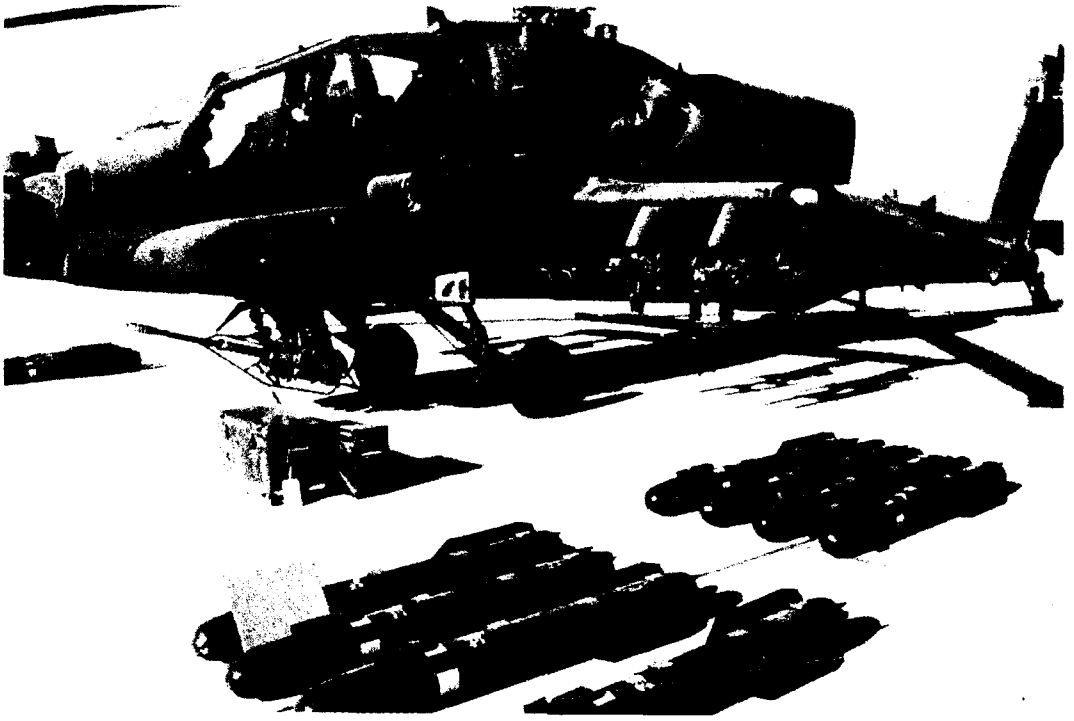
Shortcomings

- AH-1s lacked a night targeting system, such as a forward-looking infrared (FLIR) and an autonomous laser designator. This severely restricted night and adverse weather operations and the use of Hellfire missiles.
- AH-1s lack a self-contained, precision navigation system like GPS.
- Reserve AH-1Js were not antiarmor capable.

Issues

- The number of AH-1Ws in each of six active and two reserve USMC Cobra squadrons will increase to 18 by FY97.
- Lack of a night targeting system and an on-board laser designator will be alleviated with the introduction of the Cobra Night Targeting System, (IOC FY 93).
- Lack of a navigation FLIR is addressed in a draft operational requirement for a mid-life upgrade to the AH-1W. Lack of a self-contained, precision navigation system will be corrected with the installation of GPS in the AH-1W, scheduled to begin in FY 93.

AH-64 APACHE ATTACK HELICOPTER



Mission

The AH-64 is the Army's primary antiarmor attack helicopter. The AH-64 is able to locate, engage and destroy enemy armored vehicles and other enemy targets in day, night, and other limited visibility conditions.

System Data

Prime Contractor: McDonnell Douglas Helicopter Co.
Crew: Two
Initial Operational Capability: 1986
US Inventory: 616
Length: 49 ft
Rotor Diameter: 48 ft
Maximum Gross Weight: 17,650 lbs
Speed: 145 knots
Range: 162 miles (combat radius)
Endurance: 1.8 hours
Armament: Hellfire missiles, 2.75 inch Hydra rockets, 30 mm cannon
Avionics: Forward-looking infrared (FLIR);Target Acquisition and Designation Sight; Integrated Helmet and Display Sight System; Pilots Night Vision System (PNVS)

Employment

The 274 AH-64s deployed to SWA were used to conduct deep attacks, raids, close battle, and armed reconnaissance missions. These aircraft represented 45 percent of the Army's AH-64 fleet.

AH-64s were used in the first attack of Operation Desert Storm, destroying a critical air defense complex deep inside Iraq. A few days before the start of the Offensive Ground Campaign, AH-64s conducted raids behind fixed Iraqi defensive positions, identified Iraqi border positions and used lasers to designate those positions for artillery-fired Copperhead rounds.

During operations in poor weather, thick smoke, or low visibility, the AH-64 was used as an armed reconnaissance asset, because other aircraft lacked the Apache's survivability, range, mobility and versatility.

Commanders used the AH-64 in a movement to contact role forward of advancing ground forces to assist in keeping our own forces separated from each other while engaging and destroying Iraqi units. The AH-64 destroyed Iraqi equipment and fortifications while providing intelligence to the advance ground elements.

Performance

The AH-64 had the ability to fight from several miles distance, rendering enemy weapon systems less effective. The AH-64s flew more than 18,700 hours with a mission capable rate exceeding 90 percent during the war.

AH-64s conducted armed zone and route reconnaissance deep into enemy territory at night. The aircraft's advanced optical systems helped with navigation and filming terrain and enemy unit dispositions for intelligence analysis. The AH-64 was successful in fast-paced, joint offensive and defensive operations.

The aircraft's auxiliary power unit, environmental control unit, and shaft driven compressor lacked adequate filtration systems to counter the harsh desert environment. Excessive amounts of sand were ingested, damaging these systems. Limited radio transmission ranges hindered the ability to communicate with AH-64s, particularly at low altitudes and during deep interdiction operations.

Though the AH-64 is credited with destroying numerous tanks, trucks and armored vehicles, only one AH-64 was lost to enemy action and its crew was recovered uninjured.

OBSERVATIONS

Accomplishments

- The rapid deployment features of the AH-64 (six in one C-5A) enhanced the antiarmor capability in the theater during the first days of the crisis.
- AH-64s conducted the first attacks in Operation Desert Storm, destroying critical air defenses at night and with total surprise to open an air corridor for Coalition air forces.
- The AH-64 was a valuable maneuver asset during the fast paced, joint ground operations.
- The AH-64 was the only aircraft able to fight in concert with ground forces during certain periods of adverse weather.

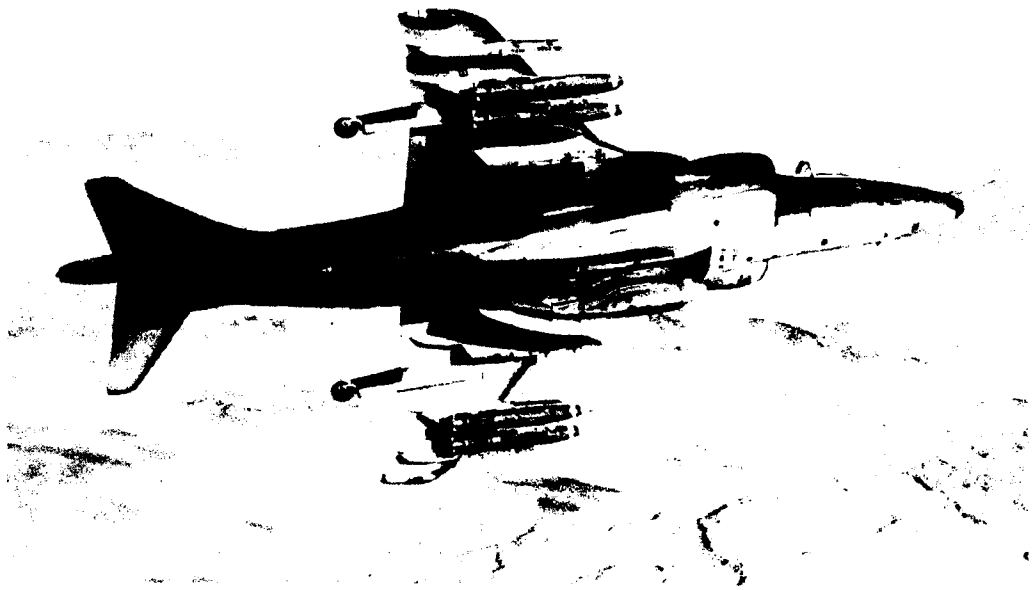
Shortcomings

- The harsh desert environment, especially sand, adversely affected aircraft components.
- Limited radio transmission ranges hindered the commanders' ability to communicate with AH-64s.

Issue

- Changes are being considered to improve the aircraft and resolve the shortcomings identified during Southwest Asian operations. These include Global Positioning System for navigation, Single Channel Ground Air Radio System for communications, a flight data recorder, and an improved fire control computer.

AV-8B HARRIER STOVL AIRCRAFT



Mission

The Marine Corps' (USMC's) Short Takeoff and Vertical Landing (STOVL) AV-8B Harrier aircraft conducts deep and close air support (CAS), armed reconnaissance, air defense, and helicopter escort missions. The AV-8B can operate from suitable seagoing platforms, advanced bases, expeditionary airfields, and remote tactical landing sites. Using STOVL technology for basing flexibility, it can respond quickly to the ground commander's need for timely CAS.

System Data

Prime Contractor: McDonnell Douglas
Crew: One Pilot
Initial Operational Capability: 1984
US Inventory: 170
Length: 46.3 ft
Wingspan: 30.3 ft
Weight: 31,000 lbs maximum takeoff
Speed: 0.91 Mach at sea level
Range: 506 miles (combat radius)
Propulsion: One Rolls-Royce Pegasus F402 turbofan engine
Armament: Mk-80 Series Bombs; 25mm Gatling gun; MK-20 Rockeye cluster bomb; AIM-9 Sidewinder; MK-77 Firebombs; 2.75" & 5" rockets; AGM-65E Maverick; mines; CBU-72 fuel air explosive; Laser-guided bombs

Employment

Eighty-six AV-8Bs were deployed in support of Operation Desert Storm. Two AV-8B squadrons (40 aircraft) arrived in the theater on 19 and 20 August to protect against further Iraqi aggression and provide air support for USMC forces. Twenty-six more Harriers were deployed on ships in the Persian Gulf and an additional squadron of 20 aircraft arrived in theater on 22 December. When Operation Desert Storm began, AV-8Bs attacked Iraqi long-range artillery within the Kuwait Theater of Operations (KTO). Other primary targets included armor and troops in the USMC area of responsibility. Immediately before the ground offensive, AV-8Bs conducted intensive operations to prepare the battlefield for ground forces to breach the minefield and obstacle belts in their advance to Kuwait City. AV-8Bs from main bases, amphibious assault ships (LHAs) and unimproved airfields (airfields offering refueling and ammunition with only minor maintenance repair capability) specialized in CAS which required detailed coordination with Coalition ground forces.

Harriers were deployed aboard LHAs to support Marine Expeditionary Brigade operations in the Persian Gulf. A squadron of 20 aircraft had deployed aboard *USS Nassau* (LHA 4) and a detachment of six aircraft was deployed on *USS Tarawa* (LHA 1). The detachment of six aircraft flew to King Abdul Aziz Naval Base on 15 February and operated from this site for the rest of the war. Sea-based combat missions were flown from 20 February through 27 February. AV-8Bs on *USS Nassau* flew 56 combat missions on the third day of the ground offensive for a rate of nearly three sorties per aircraft.

Performance

During multi-aircraft strikes, the Harrier's STOVL capability allowed 24 AV-8Bs to recover at their main base at King Abdul Aziz in less than five minutes. The airfield had an unimproved asphalt surface which needed repair, with minimal taxiways and little ramp space. Twelve aircraft routinely took off in less than two minutes. The aircraft's flexibility conducting short takeoffs, rolling vertical and vertical landings, allowed compressed launch and recoveries in a dense air traffic control environment. The STOVL capabilities allowed AV-8Bs to continue combat operations when the field was closed to other fixed wing operations because a disabled aircraft blocked the runway. AV-8Bs were able to continue takeoffs and landings from either end of the airfield, in less than 3,000 feet.

Harriers provided a rapid response capability against Iraqi long-range artillery by standing strip alert. Eighteen of these missions were conducted in one hour during the ground war as Marines assaulted north to Kuwait City.

Basing flexibility also allowed the AV-8Bs to be the northern most deployed fixed-wing aircraft in theater. AV-8B operations began at Tanajib forward base only 42 miles south of the Kuwaiti border, on 18 February. Basing closer to the front lines eliminated the requirement for air refueling and provided quick response times. Moreover, aircraft with emergencies were able to recover at forward bases.

Location	To KTO	Load [1]	TOS
Main Base	114 miles	6 X MK-20/MK-82	30 min
Forward Base	42 miles	6 X MK-20/MK-82	45 min
LHA	72 miles	4 X MK-20/MK-82	30 min

[1] Plus 300 rounds 25mm and ALQ-164 DECM pod.

AV-8B targets included artillery, tanks, armor vehicles, ammunition storage bunkers, convoys, logistics sites, troop locations, airfields, and known antiaircraft artillery /surface-to-air missile (SAM) locations. AV-8Bs expended 7,175 Mk-20 Rockeye cluster bombs, 288 Mk-83 bombs, 4,167 Mk-82 bombs, and 83,373 rounds of 25-mm machine gun ammunition. In the last 10 days of the war, 236 sorties were flown from the forward base, carrying 187 tons of ordnance. From this site, 1,288 MK-20 Rockeye and 1,609 MK-82s were delivered against targets in the KTO. During quick turn-arounds, AV-8Bs routinely were rearmed and refueled in an average of 20 to 25 minutes. One section was turned around in less than 17 minutes.

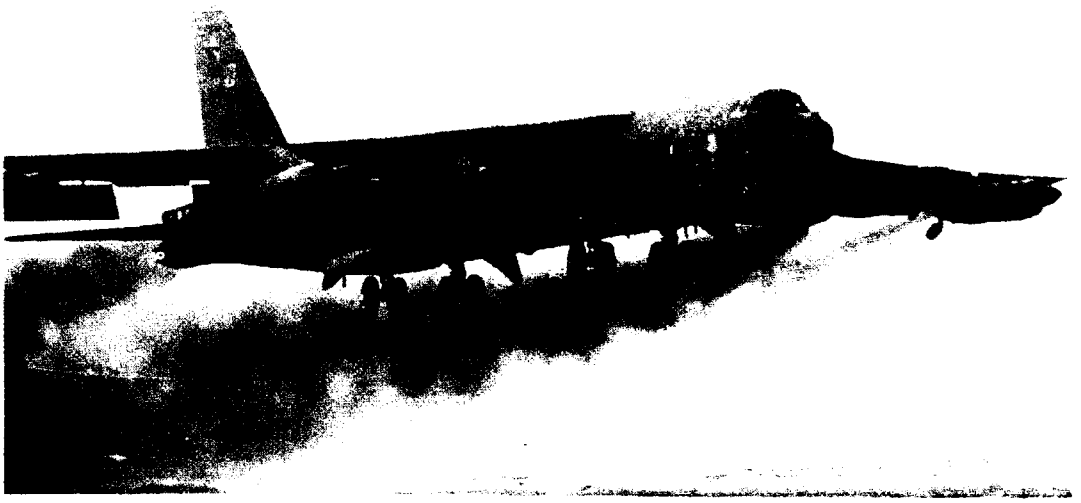
Harriers based at the front of the battle area provided quick response to air requests with effective combat loads. AV-8B missions were not delayed or complicated by air refueling. Missions were flown from LHAs and forward bases to targets in the KTO. Harriers flew 3,342 sorties in more than 4,317 flight hours while maintaining an 83 percent full mission capable rate and 88 percent mission capable rate. To provide better support for the ground forces, the AV-8Bs frequently operated below the mid-altitude sanctuary.

OBSERVATIONS

Accomplishments

- AV-8Bs were effective and responsive in their primary role of supporting ground forces. The AV-8B was successful in neutralizing the USMC main concern – long-range artillery.
- AV-8Bs maintained an 83 percent full mission capable rate and a 88 percent mission capable rate during combat.
- AV-8Bs aboard the *USS Nassau* proved an LHA can effectively be used as a strike platform.

B-52 STRATOFORTRESS BOMBER



Mission

The B-52 is a multi-mission intercontinental heavy bomber aircraft. It can fly at high subsonic speeds at altitudes up to 50,000 feet and can carry nuclear or conventional ordnance. Numerous modifications have been made to the B-52 including the new Offensive Avionics System, Integrated Conventional Stores Management System, Global Positioning System, and electronic countermeasures improvements making the aircraft more survivable and more accurate. In a conventional scenario, the B-52's large payload and wide variety of munitions allows it to conduct air interdiction, and battlefield air interdiction (BAI) missions. Two types of B-52Gs were used in Operations Desert Shield and Desert Storm.

ALCM B-52G: Primary mission is nuclear deterrence using the Air Launched Cruise Missile, Short Range Attack Missile, and nuclear gravity bombs. Conventionally, the ALCM B-52G has the same internal carriage capability as the conventional B-52G. However, the aircraft is limited to external carriage of up to 1000-lb class munitions.

Conventional B-52G: 41 B-52Gs were modified to improve their conventional capabilities. These aircraft can carry a full range of conventional munitions internally and externally along with standoff munitions such as Have Nap and Harpoon. Other modifications have improved bombing accuracy and ability to conduct conventional operations.

System Data

Prime Contractor: Boeing Aircraft Co.
Crew: Six - aircraft commander, pilot, radar navigator, navigator, electronic warfare officer, and gunner (gunner position recently deleted)
Initial Operational Capability: 1959
US Inventory: 118
Length: 160 ft 11 in
Wingspan: 185 ft
Combat Weight: 488,000 lb
Speed: 440 knots (true air speed at normal cruising altitude of 35,000 feet)
Range: 5,016 miles (unrefueled with typical combat load)
Propulsion: Eight Pratt and Whitney J57-P-43 WB Turbojets
Armament: Approximately 70,000 lbs of mixed ordnance including general purpose bombs, naval mines, standoff munitions, special purpose weapons, and cluster bomb units (CBU). Defensive armament includes four .50-caliber machine guns, chaff, and flares

Employment

Deployment of 20 B-52Gs occurred early in Operation Desert Shield. As the air campaign evolved, the B-52 force grew to 68 B-52Gs, which were used to attack targets in Iraq and Kuwait.

Deployed bomber units developed and flew 335 missions against chemical and nuclear sites, railroad yards, logistics sites, barracks, airfields, weapon sites, Scud missile sites, power production facilities, military industrial sites, and integrated air defense systems. For BAI targets, 442 packages were planned against armor; command, control, and communications (C^3) facilities; infantry and mechanized infantry; minefields; logistics; tactical vehicles; artillery; and ammunition supply points. In addition, B-52 packages were important for psychological operations. A total of 527 BAI sorties were flown during Operation Desert Storm.

Performance

The B-52G bombers which operated in Operation Desert Storm were among the older aircraft in the theater. The aircraft delivered more than 54 million pounds of bombs without a combat loss.

Seven B-52s taking off from Barksdale AFB, LA carrying conventional air-launched cruise missiles (ALCMs) were launched prior to H-Hour as part of Operation Desert Storm. These round-trip sorties, flying a total distance of over 14,000 miles and remaining aloft for over 35 hours, were the longest combat missions in history and the first combat employment of the conventional ALCM. The B-52s launched 35 conventional ALCMs from outside Iraq's air defense network in Desert Storm's opening hours, with the ALCMs programmed to attack eight targets, including military communications sites and power generation/transmission facilities.

B-52s also struck five targets inside Iraq as part of Operation Desert Storm's initial attack. Four targets were forward operating airfields: As Salman, Glalaysan, Wadi Al Khirr, and Mudaysis. The fifth target was Al Khafi, a forward operating location highway airstrip. It was essential to neutralize these targets in the opening hours of the war. A total of 13 B-52s launched in the opening attack, using mixed loads of weapons (UK-1000, CBU-58, and CBU-89). One B-52 sustained minor damage when it was hit leaving the target area, but there were no casualties.

Night low-level operations against strategic targets continued through the third day of Operation Desert Storm. After striking the Uwayjah petroleum refineries during the air campaign's third night, a B-52G apparently was hit by a missile or antiair artillery, but the aircraft returned to its base safely. After the fourth day, all B-52 missions were conducted at high altitudes.

B-52Gs conducted around-the-clock bombing operations against various targets. B-52s flew 79 offensive counterair sorties against airfields, aircraft on the ground, and airfield supporting infrastructure using general purpose bombs and cluster bomb units. Resulting damage disrupted and prevented air operations.

B-52s flew 954 air interdiction sorties against strategic targets (industrial facilities, C3 facilities, nuclear/chemical/biological facilities, and short-range ballistic missiles), interdiction targets including Republican Guard units as well as fixed installations such as petroleum, oil and lubricant storage facilities, and railroads. Most raids were conducted at high altitude using radar ground mapping for target acquisition.

B-52Gs flew 527 BAI sorties striking armor, mechanized, and infantry units with a variety of general purpose and cluster bomb munitions. Continual day/night bombing of ground units was devastating to the units' effectiveness.

OBSERVATIONS

Accomplishments

- B-52s carrying conventional ALCMs flew over 14,000 miles and remained aloft for over 35 hours, representing the longest combat sorties in history.
- B-52Gs flew more than 1,600 sorties, dropped more than 72,000 weapons, and delivered more than 27,000 tons of munitions on targets in Iraq and Kuwait without a combat loss.
- The B-52 large payload allowed them to assist breaching operations through enemy ground defenses conducted by Coalition ground forces.
- The B-52G, although comprising only three percent of the total combat aircraft, delivered 30 percent of the total tonnage of air munitions.

Shortcomings

- Lack of available bases in the theater caused three of the four bomber wings to fly 14 to 16 hour missions routinely and thus limited combat sortie rates.
- The B-52's lack of a precision-guided munitions capability limited target selection to large area targets.
- The B-52's lack of stealth attributes required large force protection packages to escort or support their attacks against defended targets.

CH-46 SEA KNIGHT TRANSPORT HELICOPTER

Mission

The CH-46E was designed to move combat troops, support equipment, and supplies rapidly from amphibious assault landing ships and established airfields to advanced bases in undeveloped areas with limited maintenance and logistic support. The Navy also uses the CH-46D model for vertical replenishment, intra-battlegroup logistics, medical evacuation, and search and rescue missions.

System Data

Prime Contractor: Boeing Vertol
Crew: Four
Initial Operational Capability: 1964
US Inventory: 324
Length: 45 ft 8 in
Rotor Diameter: 51 ft
Gross Weight: 24,300 lbs
Max Speed: 145 knots
Range: 110 miles (one way)
Endurance: 2 hours (CH-46D), 1.75 hours (CH-46E)
Armament: Two M2 (.50 caliber) or M60 (7.62 mm) machine guns (CH-46Es only)

Employment

A total of 120 USMC CH-46E aircraft in 10 squadrons (nine active and one reserve) and 42 Navy CH/HH-46D in 21 two aircraft detachments, were deployed to support Operations Desert Shield and Desert Storm. The aircraft were used to transport Marines, Navy personnel, cargo, mail, ordnance, external loads, and to conduct medical evacuation (MEDEVAC) missions and search and rescue missions.

Performance

During Operations Desert Shield and Desert Storm, the Marine CH-46Es supported the scheme of maneuver ashore, and the 21 CH-46D detachments moved approximately 37,000 passengers, 4.6 million pounds of mail, 3.9 million pounds of internal cargo, and 90,000 tons of external cargo, the majority of which was ordnance. Additionally, 313 SAR and MEDEVAC missions were conducted. CH-46Ds and CH-46Es each flew more than 15,000 hours. Mission capable rates during Operation Desert Storm were 87.3 percent for CH-46Ds and 76.2 percent for CH-46Es.

Flight restrictions on rotor head dynamic components reduced the aircraft's gross weight, increased special maintenance inspections, and limited operational capability. The aircraft's limited airspeed and fuel capacity restricted its range to 102 miles with no loiter time. Internal fuel tanks extended the aircraft's range, but limited the aircraft's internal space and cargo-carrying capability.

Inherent limitations of night vision goggles emphasized the requirement for a complementary forward looking infrared (FLIR) system for operations during reduced visibility. The CH-46 lacks an integrated self-contained precision navigation system, which limited its ability to perform missions.

OBSERVATIONS

Accomplishments

- Twenty-one CH-46D detachments moved approximately 37,000 passengers, 4.6 million pounds of mail, 3.9 million pounds of internal cargo, and 90,000 tons of external cargo.
- CH-46Ds flew more than 15,000 hours with MC/FMC rates of 92 and 87 percent respectively.
- CH-46Es flew more than 15,000 hours with a MC rate of 76.5 percent.
- CH-46s conducted 313 SAR and MEDEVAC missions.

Shortcomings

- The CH-46's limited airspeed and fuel capacity restricted its effective range, especially in over-the-horizon operations.
- Turbine blade erosion caused by the desert environment reduced engine life.
- The CH-46s are approaching airframe/dynamic component life limits.
- Lack of spare parts increased aircraft down time.
- Frequent inspection cycles decreased mission availability.
- Lack of self-contained navigational information adversely affected its ability to conduct long range missions. The desert's featureless terrain, coupled with the CH-46's lack of external navigation systems, emphasized the requirement for a self-contained precision navigation capability.

Issues

- NVG limitations emphasized the requirement for a complementary FLIR system for periods of reduced visibility, but there are no plans to install a FLIR system on CH-46 aircraft.

- Dynamic component Upgrade Program will provide newly manufactured dynamic components to increase the useful life of the aircraft, correct safety deficiencies, and reduce maintenance and special inspections.

- The CH-46 upgrade program will increase range and navigational capability.

- A rotor wing head pitch shaft modification will correct a known safety deficiency and reduce the number of required safety inspections.

CH-47D CHINOOK TRANSPORT HELICOPTER

Mission

The CH-47D is a medium lift transport helicopter used primarily to transport personnel, weapons, ammunition, equipment and other cargo in general support of combat units. Most operations consist of transporting supplies and external loads.

System Data

Prime Contractor: Boeing Vertol
Crew: Three
Initial Operational Capability: 1984 ("D" configuration)
US Inventory: 344
Length: 50.75 ft
Rotor Diameter: 60 ft
Maximum Gross Weight: 50,000 pounds
Speed: 140 knots (cruise)
Range: 360 miles
Endurance: 2.2 hours
Armament: Two 7.62 machine guns
Payload: 24,000 pounds

Employment

During Operations Desert Shield and Desert Storm, 163 CH-47s deployed to Southwest Asia (SWA). Ten medium helicopter companies deployed. This represented 47 percent of the CH-47D aircraft fielded.

While in SWA, the CH-47D transported troops and equipment into combat, resupplied the troops in combat, performed medical evacuation, transported bulk supplies, and repositioned reserve forces. It was the only Army helicopter capable of rapidly repositioning extremely heavy equipment in the harsh desert environment.

Performance

The aircraft was used extensively to establish refueling/rearming sites in support of deep operations, to conduct long-range rescue missions, and to move large numbers of enemy prisoners of war. The CH-47D often was the only mode of transportation available to shift large numbers of personnel, equipment, and supplies rapidly across the vast area in which the forces operated. The aircraft was instrumental in maintaining lines of communication and supply to combat units deployed well forward on the battlefield.

The CH-47D normally operates in secure areas; however, during the ground offensive, the CH-47 played an integral part in the air assault. On the first night of the ground campaign, CH-47Ds of the 101st Airborne Division (Air Assault) participated in the largest air assault operation ever conducted. Moving heavy weapons such as the M-198 howitzer, CH-47Ds allowed the 101st Airborne Division (Air Assault) to carry much needed fire support with the initial air assault elements.

By the end of the first day of the ground offensive, four teams of CH-47s had lifted 131,000 gallons of fuel and numerous pallets of ammunition. The food and water for the entire air assault force was carried on three CH-47Ds.

The CH-47Ds flew more than 13,700 hours in SWA; the mission capable rate exceeded 75 percent before Operation Storm (the standard is 70 percent) and 85 percent from January through February.

There were reports of infrared and radar-guided missile engagements against CH-47D helicopters; however, no aircraft were lost in these engagements.

OBSERVATIONS

Accomplishments

- The CH-47D proved to be a reliable asset, flying more than 13,700 hours in support of SWA operations. The aircraft displayed speed and versatility while participating in the largest air assault in history.

- It provided the ability to move vast amounts of personnel, weapons, supplies, ammunition, fuel and other supplies required to support ground tactical plan.

Shortcomings

- Heavy divisions reported a need for more CH-47D support.

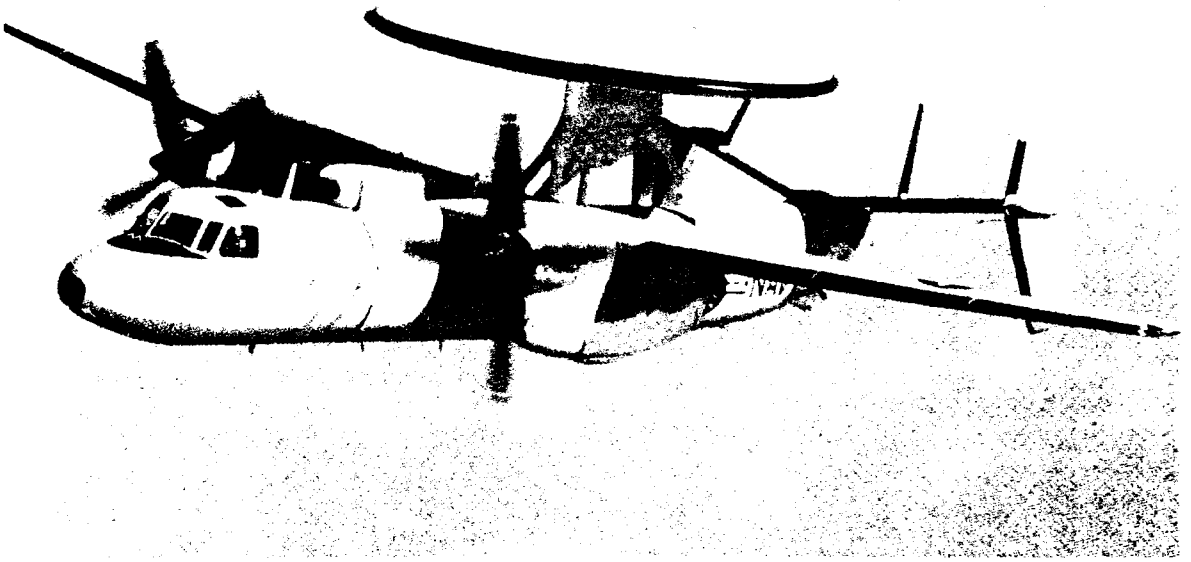
- Accurate navigation was difficult in the featureless terrain environment.

- The aircraft suffered sand erosion problems with the rotor blades, engines, and oil coolers.

Issue

- Improvements under consideration are, the Global Positioning System for navigation; ANVIS/HUD for NVG operations; Single Channel Ground and Airborne Radio System for communications; and, environmental protection filters and covers.

E-2C HAWKEYE AEW AIRCRAFT



Mission

The E-2C HAWKEYE is an all-weather, carrier-based airborne early warning (AEW) and command and control (C2) aircraft with a crew of five: pilot, co-pilot, combat information center officer, air control officer, and radar operator. Additional missions include surface surveillance coordination, strike and interceptor control, search and rescue guidance and communications relay.

System Data

Prime Contractor: Grumman Aerospace Co.
Crew: Five
Initial Operational Capability: 1973
US Inventory: 113
Length: 57 ft 8 in.
Wingspan: 80 ft 7 in
Weight: 53,000 lbs maximum takeoff
Cruising Speed: 270 knots
One-way Range: 1,673 miles
Propulsion: Two Allison T56-425A Turboprop engines, 4,910 ESHP each
Armament: None

Employment

The E-2C is both a land-based and carrier-capable aircraft used by the Navy and some foreign countries. Each E-2C is expected to generate about 1.5 sorties a day with a sortie length of approximately 4.5 hours. Normally four or five E-2Cs are embarked on a carrier (CV) and at least one E-2C is kept airborne to provide AEW, C2, and communications relay functions for a CV task force. Each E-2C carries an APS-138 radar which operates at 400 Mhz; an ALR-73 electronic support measures (ESM) system, identification, friend or foe (IFF) interrogators; one very high frequency, five ultra high frequency, and two high frequency radios; and, several data links including Link-11 (TADIL A) and Link-4A (TADIL C). The E-2C normally cruises at 270 knots at about 25,000 feet.

The E-2C was used in all mission areas including offensive support coordination, intelligence collection, and anti-surface warfare. The first E-2Cs were operational in theater on 7 August. The aircraft operated from three CVs in the Red Sea and three CVs in the Persian Gulf. Three CVs had four E-2Cs embarked while the remainder had five E-2Cs embarked. Beginning on 10 December, four shore-based E-2C aircraft also began operations from Bahrain. Flights were scheduled to support the Persian Gulf Anti-Air Warfare (AAW) Commander by augmenting Airborne Warning and Control System (AWACS) coverage during anticipated periods of peak Iraqi air activity and provide AEW coverage during AWACS refueling. This shore-based coverage remained in operation until *USS America* (CV-66) and *USS Theodore Roosevelt* (CV-71) arrived in theater.

Performance

During Operation Desert Storm, 27 E-2C aircraft were in theater. A total of 1,192 sorties were scheduled with 1,183 flown for a total of 4,790 flight hours. Mission capable (MC) rate was 83 percent and full mission capable rate was 69 percent. Total mission completion rate was 99 percent. Overall, the performance of the E-2C over land far exceeded operator expectations. This success was attributable to two major factors: system grooming and operator training.

Overwater radar detection and tracking performance was excellent as expected. Pseudo-Synthetic Video (PSV) and Real-Time Synthetic Video (RTSV) were available consistently for targets at near to medium ranges and only slightly less for targets at longer ranges.

As expected, land/sea interface was the most difficult area for E-2C detection and tracking. Automatic tracking was essentially non-existent. Manual tracking with a dedicated operator who focused on an area of interest was necessary. AMTI video was available on known contacts.

Overland performance consistently exceeded expectations. Radar-only fighter control and continuous tracking of aircraft on the overland low levels were commonplace. The primary threat sector to the north offered the radar's optimum overland environment. While there were only limited opportunities to gather statistical data on detection and tracking of high speed, low altitude targets in the threat sector, tactical aircraft were tracked routinely at medium altitudes. Mission crew debriefs indicated excellent tracking of low-altitude RAF GR-1 aircraft. Both bypass and canceled RTSV proved effective in painting Iraqi tactical aircraft. Only minimal false alarms were encountered. Commercial air targets were routinely detected at long range.

OBSERVATIONS

Accomplishments

- The E-2C coordinated communications shifts, provided situational awareness to Coalition aircraft through all flight phases, and provided backup radar coverage and control for flights in hostile territory.

- Integration of E-2C and AWACS radar pictures provided superior situational awareness to both platforms and exceptional E-2C target area control of strike aircraft.

Shortcomings

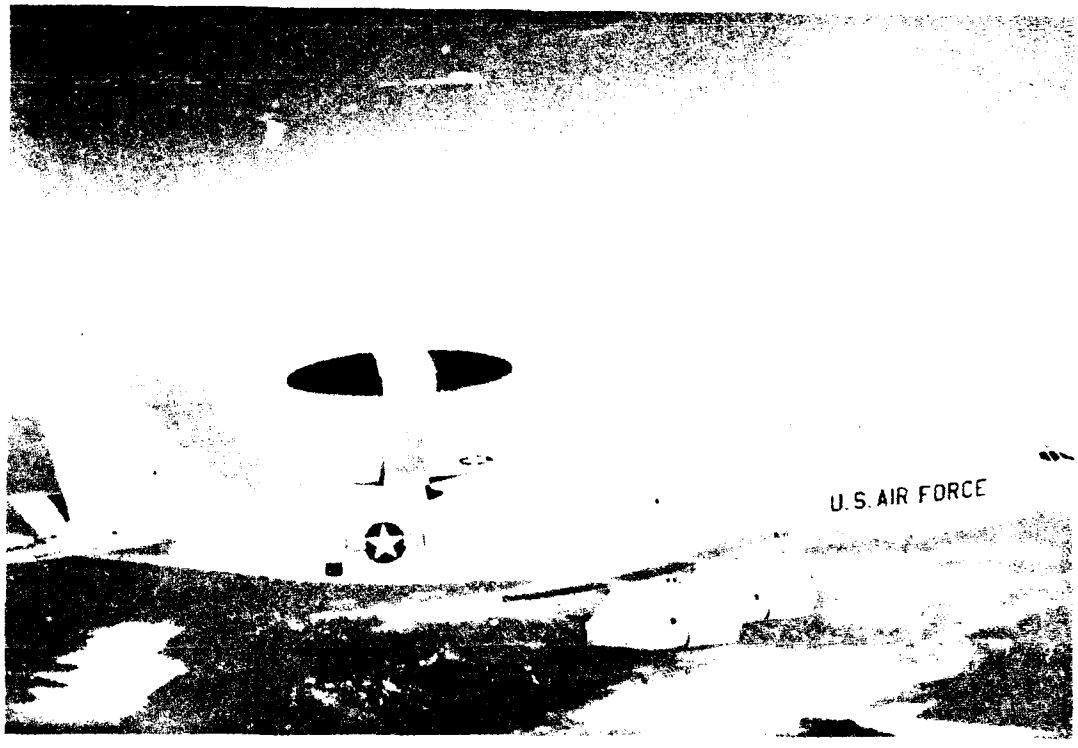
- Lack of an over-the-horizon communications suite was a distinct disadvantage. The addition of a satellite communications capability in the E-2C would have added tactical flexibility when operating at extended distances from the CV battle group.

- The lack of in-flight refueling capability limited the E-2C's range and endurance.

Issue

- The next upgrade of the E-2C – the Group-II-APS-145 equipped aircraft –will resolve many of the identified shortcomings.

E-3 AWACS AIRCRAFT



Mission

The E-3 Airborne Warning and Control System (AWACS) provides highly mobile, survivable airborne surveillance and command and control (C^2) functions for tactical and air defense forces. It provides all-altitude surveillance of airborne targets over land and water. The AWACS missions are to detect enemy aircraft, control defensive friendly fighters, control strike aircraft and provide a long-range air picture to theater commanders and other command forces.

System Data

Prime Contractor: Boeing Aerospace Co, airborne radar built by Westinghouse
Crew: Flight crew of four plus 19 to 29 mission specialists
Initial Operational Capability: 1977
US Inventory: 33
Length: 145 ft, 6in
Wingspan: 130 ft, 10in
Weight: 325,000 lbs
Cruise Speed: 460 knots
Range: 24 hours flight time refueled (limited by crew rest requirements), more than 11 hours flight time unrefueled
Propulsion: Four Pratt and Whitney TF-33-PW-100A turbofan engines
Armament: None

Employment

The E-3 is a land-based airborne early warning and control aircraft used by the Air Force (USAF), the Royal Saudi Air Force, North Atlantic Treaty Organization (NATO), and other countries. E-3s normally are operated as individual aircraft, often maintaining a surveillance station around the clock using multiple aircraft in sequence. Only E-3B/C aircraft were deployed to Operations Desert Shield and Desert Storm.

Five E-3s initially were deployed to Riyadh, Saudi Arabia, arriving on 8 August and an E-3 orbit was established the next day about 110 to 125 miles from the Kuwaiti and Iraqi borders. During Operation Desert Shield, there was a gradual buildup of E-3s in Riyadh until 11 were available by 16 January. On 15 January, three E-3s deployed to Incirlik, Turkey, to begin operations in Southeast Turkey, about 120 miles from the Iraqi border. (In addition, NATO-owned E-3s were used in the Mediterranean to monitor the flow of aircraft towards Southwest Asia and for maritime interception surveillance. They also flew over Turkish territory to maintain Turkish air sovereignty.)

Performance

At the start of Operation Desert Storm, four US E-3s were airborne over Saudi Arabia (three forward, one to the rear) and one US E-3 over southeast Turkey. In addition, there was a Saudi E-3 in southern Saudi Arabia used primarily for communications relay. The rearmost US E-3 in Saudi Arabia was primarily used to manage air refueling operations. This configuration of airborne E-3s was maintained 24 hours a day throughout most of Operation Desert Storm. E-3s, at times, overflew Iraq to provide additional radar coverage against deep target areas. E-3s did benefit from airborne combat air patrol established near the E-3 orbit to protect all high value airborne assets (HVAA) to include AWACS, Joint Surveillance Target Attack Radar System, and Rivet Joint.

E-3s supported all daily air tasking order activity, controlling an average of 2,240 sorties a day and a total of more than 90,000 sorties during the war. AWACS provided direct support of offensive counter air and defensive counter air combat patrols. During Desert Storm, AWACS flew 448 sorties for 5,546 flying hours. In addition to controlling combat aircraft, AWACS helped to ensure there were no Coalition mid-air collisions. No AWACS were damaged and no AWACS personnel were injured as a result of enemy action.

Throughout Operations Desert Shield and Desert Storm, AWACS provided the primary air picture to the appropriate theater C2 centers through voice and electronic data links for 100 percent of tasked station time. The E-3, operating in conjunction with Marine Corps (USMC), Navy, Army, USAF, and Saudi Arabian units, provided an air picture that spanned from the Persian Gulf to the Red Sea, providing real time information to most Coalition command centers. The E-3 established a data sharing network with the RC-135 Rivet Joint, Airborne Battle Command and Control Center, Tactical Air Control Center (TACC) and Navy E-2s. The complete theater air picture was passed through this network. The TACC relayed information data link to USMC and Army units, and the Saudi Arabian-led Coalition C2 centers. AWACS also provided primary support to all aircraft requiring pre- and post-strike air refueling in northern Saudi Arabia.

OBSERVATIONS

Accomplishments

- AWACS demonstrated excellent deployability, arriving in theater on 8 August.
- During Operation Desert Storm, E-3s provided medium altitude radar coverage of Iraqi airspace while operating from Saudi and Turkish airspace.
- AWACS provided threat warning to all assigned strike packages inside hostile territory and provided threat warning and deconfliction of all HVAA in theater.

Issue

- The usefulness of long-distance, communications between widely separated E-3s covering related areas should be investigated.

EA-6B PROWLER ECM AIRCRAFT

Mission

The EA-6B is a four-seat carrier- and land-based aircraft incorporating comprehensive electronic countermeasures (ECM) equipment to jam enemy radars and communications. The tactical jammers are carried in external pods. The radar intercept receivers, mission computers and aircrew displays are carried internally.

System Data

Prime Contractor: Grumman Aerospace Co.
Crew: One pilot; three electronic countermeasures officers
Initial Operational Capability: 1971
US Inventory: 133
Length: 59 ft.
Wingspan: 53 ft.
Weight: 61,500 lbs maximum takeoff
Speed: Maximum 0.99 Mach; Cruise 0.72 Mach
Range: 852 miles
Propulsion: Two Pratt and Whitney J-52 P-408 turbojet engines
Armament: High Speed Anti-radiation Missile (HARM)
Onboard Weapons System: ALQ-99 Tactical Jamming System; ASQ-191 Communications Jamming System
External Stores (five stations available): ALQ-99 Jamming Pod (five max); AGM-88 high-speed anti-radiation missile (four maximum), external fuel tanks (five maximum), ALE-41 Chaff Pod (five maximum), and ALQ-167 Jamming Pod (four maximum)

Employment

The Navy and Marine Corps (USMC) used the EA-6B Prowler to provide ECM during Operations Desert Shield and Desert Storm. The Prowler's mission was to deny the enemy the use of the electromagnetic spectrum. This ECM support contributed substantially to Coalition effectiveness by denying early warning and tracking data to enemy integrated air defense system (IADS) operators and by disrupting the firing solution of enemy anti-aircraft weapons. EA-6B support was considered essential for every Navy and USMC strike. The aircraft also supported coalition strikes involving aircraft of all types. It was the Navy's platform of choice for High Speed Anti- Radiation Missile (HARM) use.

The first Navy EA-6Bs arrived in the north Arabian Sea on 7 August. The first USMC EA-6Bs were operationally ready on 28 August. At the start of Operation Desert Storm, Navy EA-6Bs operated from aircraft carriers (CVs) in the Red Sea and the Persian Gulf; three CVs in the Red Sea had five EA-6Bs each while three CVs in the Persian Gulf had four EA-6Bs each. The 12 USMC EA-6Bs operated from Shaikh Isa, Bahrain. Navy Prowlers in the Red Sea generated 1.2 sorties a day per aircraft, with an average length of five hours per sortie. Persian Gulf Prowlers generated 1.3 sorties a day per aircraft with an average length of three hours per sortie. USMC Prowlers generated 1.3 sorties a day per aircraft with an average length of 2.7 hours a sortie.

On the first day of Operation Desert Storm, three Navy EA-6s with jammer pods, but no HARMs, supported a strike on Al Taqaddum west of Baghdad; three EA-6s with jammer pods and one HARM each supported an attack on H-3 in western Iraq; four EA-6s with jammer pods and one HARM each supported an attack on H-2/H-3 in western Iraq; and, two EA-6s with two HARMs and one EA-6 with only jamming pods supported attacks on H-2/H-3 and Al Asad. On the first raid of the war, two USMC EA-6s jammed Iraqi EW/GCI radars to screen Coalition inflight refueling operations, while five other EA-6s supported a large F/A-18 strike on Tallil airfield.

Performance

ECM aircraft performance is difficult to quantify. The mission is to support strike aircraft by suppressing the enemy Integrated Air Defense Systems (IADS). This can be accomplished in several different ways; effectiveness is measured by the success of the supported strike.

Prowlers flew 1,623 combat sorties, totaling 4,600 flying hours, with no combat losses; Prowlers launched over 150 HARMs. EA-6B systems jammed Iraqi radar systems, and the perceived threat of destruction from EA-6B HARMs forced Iraqi radars off the air and surface-to-air systems into highly ineffective operating modes.

OBSERVATIONS

Accomplishments

- EA-6Bs flew 1,623 combat sorties totaling 4,600 flight hours with no combat losses.

- EA-6Bs successfully provided ECM jamming and launched over 150 HARMs in support of Coalition forces.

Issue

- The next version of the EA-6B is known as the Advanced Capability (ADVCAP) Prowler. ADVCAP production begins as a remanufacture program in FY-93. New production of EA-6Bs was completed in FY-89. The EA-6B is projected to be the Navy and USMC tactical ECM aircraft well into the next century.

F-4G WILD WEASEL ECM AIRCRAFT

Mission

The F-4G Wild Weasel's mission is to destroy, neutralize, or degrade enemy radar-directed surface-to-air threats (i.e., Suppression of Enemy Air Defenses (SEAD)). The F-4G aircraft is essentially a F-4E/ARN-101 aircraft specially modified to carry the AN/APR-47 Radar Attack and Warning System which detects, identifies, and locates pulsed and continuous wave radar emitters. Although the F-4G can carry virtually every type of air-to-air and air-to-surface munition, the preferred SEAD ordnance is the AGM-88 High Speed Anti-radiation Missile (HARM).

System Data

Prime Contractor: McDonnell Douglas Aircraft Co
Crew: Two, One pilot and One Electronic Warfare Officer
Initial Operational Capability: 1978
US Inventory: 99
Length: 63 ft
Wingspan: 39 feet
Weight: 58,000 lbs maximum takeoff
Speed: Mach 2 + at 40,000 feet
Range: 600 miles
Propulsion: Two General Electric J79-GE-15 turbojet engines
Armament: Rockeye cluster bombs, air-to-surface missiles such as Shrike, HARM and Maverick and air-to-air missiles.

Employment

The Air Force (USAF) committed 63 percent (62 aircraft) of its F-4Gs to support Operation Desert Storm. Most aircraft operated from Bahrain, but 12 F-4Gs deployed to Incirlik, Turkey. The F-4Gs were used to conduct autonomous operations, direct support, and area SEAD missions. During autonomous operations, F-4Gs attacked targets in a particular geographic area to reduce the enemy air defense threat or roll back the air defenses for upcoming Coalition air operations. During direct support missions, F-4Gs joined other aircraft during a particular airstrike and provided SEAD to support that specific mission. On area suppression missions, F-4Gs were not tied to a particular strike force, but provided SEAD support for numerous strikes against various targets. The majority of F-4G missions were in the direct support role. Virtually all F-4G missions required inflight refueling.

Performance

Potential measures of performance for the F-4G force include availability, use, and mission completion rates, sorties launched, total flying time, on-station time, numbers of missiles launched and numbers of radars and other emitters damaged, destroyed, or kept off the air, the number of Coalition raids and aircraft which were saved from potential engagement, and other measures. Only limited data are now available to show how well the F-4G and associated weapons performed.

There is considerable imprecision in intelligence estimating and battle damage assessment in electronic combat, however, the general perceived threat of destruction reduced Iraqi propensity to operate their equipment. Indeed, the

potential threat of physical destruction by Anti-Radiation Missiles in general (launched from any platform: F-4G, EA-6, F/A-18) perhaps was the biggest single factor in Operation Desert Storm SEAD, as evidenced by the dramatic decrease in emissions after day one of Operation Desert Storm.

OBSERVATIONS

Accomplishments

- More than 2,700 F-4G combat sorties were flown during Operation Desert Storm, with only one combat loss.
- The perceived threat of destruction appears to have forced Iraqi radars off the air and SAM systems into highly ineffective operating modes.

F-14 TOMCAT FIGHTER

Mission

The Navy F-14 Tomcat is a variable-sweep wing, supersonic air superiority fighter capable of engaging multiple targets simultaneously from sea level to above 80,000 feet. The F-14 uses the AIM-54 long-range air-to-air missile (AAM), the AIM-7 medium-range AAM, the AIM-9 short-range AAM and the 20mm M-61A1 cannon.

There are three variants of the F-14:

F-14A - Most F-14s, equipped with the AWG-9 radar and TF-30 engines.

F-14B - New production aircraft and remanufactured F-14As equipped with F110 engines that improve thrust by 30 percent. ALR-67 compatibility and some minor structural improvements also separate the F-14B from the F-14A.

F-14D - New production aircraft and remanufactured F-14As equipped with the F110 engines, new digital APG-71 radar, digital avionics and Infrared Search and Track System. The same ALR-67 compatibility and structural improvements as the F-14B. Although listed here as a F-14 variant, the D model has not reached IOC and did not participate in Desert Storm.

System Data

Prime Contractor: Grumman Aerospace
Crew: One Pilot and One Radar Intercept Officer (RIO)
Initial Operational Capability: 1972, F-14A; 1988, F-14B; 1993, F-14D
US Inventory: 479
Length: 62 ft 8 in
Wingspan: 64 ft 1.5 in
Weight: 72,935 lbs
Speed: 780 knots / Mach 1.88
Range: 704 miles unrefueled (fighter escort mission);495 miles unrefueled (Combat Air Patrol) with one hour loiter
Propulsion: F-14A: Two PW TF30-P-414As rated at 17,077 lbs in AB each; F-14B/D: Two GE F110-GE-400s rated at 23,600 lbs. in AB each
Armament: Maximum of eight AAMs; AIM-54 Phoenix, AIM-7 Sparrow, AIM-9 Sidewinder, 20mm M-61A1 Cannon
Imagery System: Tactical Air Reconnaissance Pod System (TARPS)

Employment

The F-14A and F-14B variants were used during Operation Desert Storm for fighter sweep, CAP and escort missions. Operations were conducted day and night, at all altitudes, depending on the threat and specific mission objectives. The additional capability of the TARPS provided daytime imagery for battle damage assessment, pre-strike planning, maritime interception operations and detection of Scud missile launch site locations.

Barrier CAP missions also were flown to protect Coalition naval forces and Gulf Cooperation Council coastlines throughout the war. Later in the conflict, F-14s were used to establish and maintain CAPs to intercept Iraqi aircraft attempting to flee to Iran.

During Operation Desert Storm, 99 F-14s flew 4,182 sorties for a total of 14,248 flight hours, more than any other Navy fixed wing aircraft. The 16 F-14s configured to carry TARPS flew 751 sorties for a total of 2,552 flight hours. The F-14s

were deployed aboard five of the six carriers in theater and operated from the Red Sea and the Persian Gulf.

Performance

The F-14 never was fully challenged in its primary air superiority mission. Iraqi fighters never directly threatened Navy strike groups escorted by F-14s nor attempted forward quarter engagements against F-14 CAP or sweep missions.

The F-14 had the most flight hours of any Navy fixed wing aircraft and maintained a mission capable (MC) rate of 77 percent.

TARPS aircraft were distributed among five carriers to provide theater and strike planning support and maintained an 88 percent MC rate.

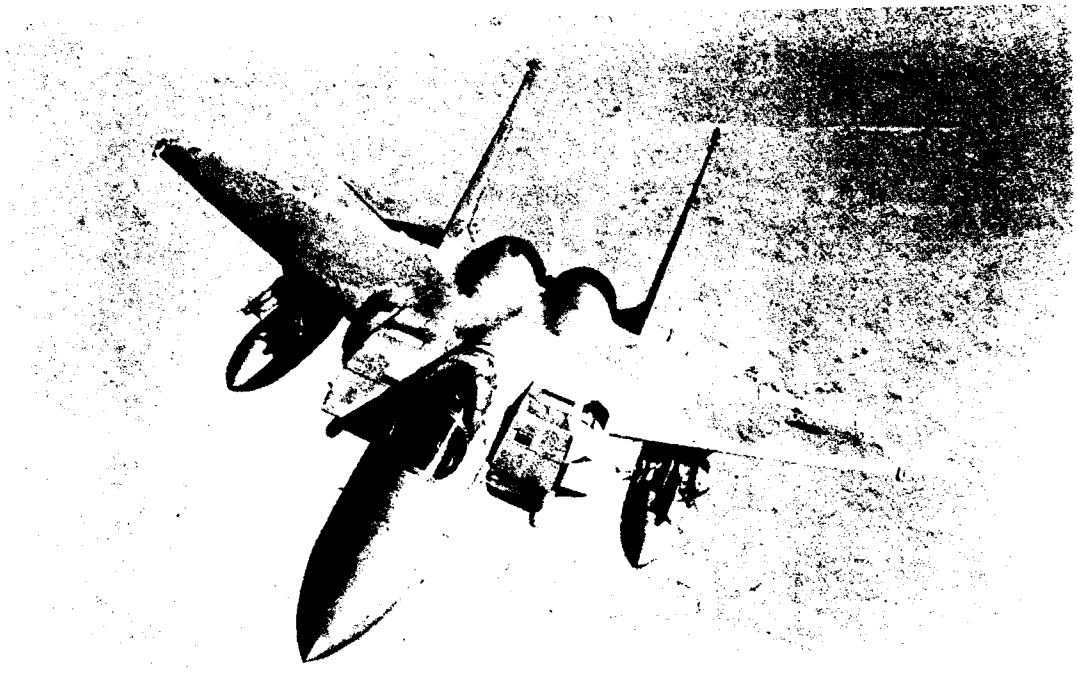
One F-14 was lost to a possible surface-to-air missile during an overland high value unit CAP mission. This loss was the only F-14 lost during Operations Desert Shield and Desert Storm.

OBSERVATIONS

Accomplishments

- F-14s conducted six intercepts against hostile aircraft, and achieved one air-to-air kill (helicopter).
- The Iraqis did not attempt a direct confrontation with F-14s.
- The F-14's range and endurance capability was an asset, since most missions required extensive flight time.
- The F-14 maintained a 77 percent MC rate.
- F-14s maintained three 24-hour CAP stations in the Persian Gulf and one in the Red Sea throughout the war, two more stations were added before the ground offensive began.
- TARPS systems had an 88 percent reliability rate.

F-15C EAGLE FIGHTER



Mission

The F-15C's mission is air superiority through offensive and defensive counter air (OCA/DCA). The F-15C provides close-in visual and medium-range, all-weather capability against any threat aircraft.

System Data

Prime Contractor: McDonnell-Douglas
Crew: One pilot
Initial Operational Capability: 1979
US Inventory: 417
Length: 63 ft
Wingspan: 42 ft
Weight: 68,000 lbs (maximum takeoff)
Speed: Mach 2.3
Range: 330 to 720 mile combat radius (configuration dependent)
Propulsion: Two Pratt and Whitney F100-PW-100 turbofan engines
Armament: One M-61A1 20 mm cannon, four AIM-9L/M Sidewinder and four AIM-7 Sparrow missiles

Employment

F-15Cs are used generally in two-aircraft formations with multiples of two comprising actual flights. Specific numbers and methods of use are tailored to individual mission objectives.

F-15C OCA/DCA missions generally are categorized as sweep, combat air patrol (CAP), or force protection. Sweep missions establish air superiority in designated areas for a specified time period by seeking out and destroying enemy aircraft within the designated area. CAP missions are used within the air defense concept to protect ground or airborne assets from attack by enemy aircraft, while the force protection mission protects friendly airborne forces from attack by enemy air. During Operation Desert Storm F-15Cs were used to intercept and destroy Iraqi aircraft, including those attempting to flee into Iran.

Twenty-four F-15Cs were among the first US-based aircraft to deploy on 7 August, a total of 118 F-15Cs eventually deployed. This force represented about 28 percent of the Air Force inventory. F-15Cs flew 5,906 OCA/DCA missions during Operation Desert Storm.

Performance

The F-15C helped attain air superiority within the first few days of the air campaign and air supremacy within 10 days. F-15Cs achieved 33 of the 38 air-to-air kills in Operation Desert Storm. This was accomplished with no F-15C losses and no incidents of air-to-air fratricide.

While F-15C pilots were well prepared to fly OCA/DCA missions and the weapon system (aircraft and weapons) proved ready and reliable, there were some system problems. Because of the distances involved and the short range radios on the F-15C, pilots had some difficulty maintaining voice contact with AWACS aircraft while maintaining CAPs over Iraq. This difficulty may have prevented timely interception of some Iraqi aircraft attempting to flee to Iran. Also, F-15Cs experienced problems with video tape recorders used to record weapons delivery. This hampered documentation of air-to-air engagements and verification of air-to-air kills.

OBSERVATIONS

Accomplishments

- The F-15C was a significant contributor to attaining air superiority in the first 10 days of hostilities.
- The F-15C achieved 33 of 38 air-to-air kills and there were no F-15C combat losses.
- There were no incidents of air-to-air fratricide.
- F-15Cs flew 5,906 OCA/DCA missions.

Shortcomings

- A low power (5 watts) radio made long-range communication difficult.
- A poor quality video recording system degraded weapons delivery documentation.

F-15E EAGLE FIGHTER

Mission

The F-15E is a high performance, supersonic, all-weather, dual role fighter. In the air superiority role, its primary weapons are radar guided and infrared homing air-to-air missiles and a 20-mm gun. In the air-to-surface role, the aircraft carries Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) targeting and navigation pods and can carry guided and unguided air-to-ground weapons. During Operation Desert Storm, the F-15E was used in offensive counter air (OCA), strategic bombing, air interdiction (AI), close air support, and suppression of enemy air defenses roles.

System Data

Prime Contractor: McDonnell Douglas Corp.
Crew: Two, pilot and weapon systems officer
Initial Operational Capability: 1989
US Inventory: 125
Length: 63.75 ft
Wingspan: 42 feet, 10 inches
Weight: 73,000 lbs maximum takeoff
Speed: Supersonic
Range: 960 mile radius
Propulsion: Two Pratt and Whitney F100-PW-220 or -229 turbofan engines
Armament: Typical weapons used during Operation Desert Storm were:
12 MK-82 (500lb general purpose bomb) or,
five MK-84 (2000lb general purpose bomb) or,
eight GBU-12 (500lb laser-guided bomb) or,
four GBU-10 (2000lb laser-guided bomb) or,
six CBU-87 (Combined effects munitions) or,
six CBU-89 (Gator mine, anti-armor/personnel) or,
six CBU-52 (Anti-personnel cluster munitions) or,
12 MK-20 (Anti-armor cluster munitions) or,
500 rounds 20 mm
four Aim-9Ms

Employment

The two F-15E squadrons that participated in Operations Desert Shield and Desert Storm had just reached operational readiness when they deployed. Operational test and evaluation on the LANTIRN pods was conducted in the area of responsibility (AOR), including the targeting pods, which were shipped to the theater after deployment. At the beginning of hostilities, 48 F-15Es were in-place and conducting operations out of Al-Kharj, Saudi Arabia.

Performance

F-15E missions were conducted almost entirely at night. The aircraft's highly flexible avionics package and the solid foundations of training and tactics provided a good baseline for the successful execution of all F-15E mission profiles.

The first night low-altitude mission and the preplanned AI packages were profiles that had been practiced extensively before the air campaign and presented very few unanticipated problems.

Two aircraft were lost during combat. The first loss occurred on 17 January during an OCA mission and the second on 19 January during an AI mission.

The F-15E's mission capable rate was 85.9 percent.

OBSERVATIONS

Accomplishments

- The LANTIRN targeting pod proved invaluable not only in destroying targets with LGBs, but also in locating the target and providing real time bomb damage assessment.

- The F-15E accomplished successfully LANTIRN operational test and evaluation in the AOR, including pods shipped after deployment.

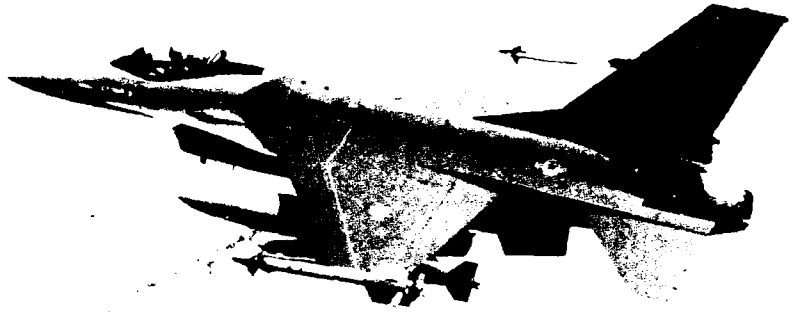
- Forty-eight F-15Es flew 2,210 sorties and dropped 1,700 GBU 10/12s using LANTIRN, along with other ordnance.

- F-15E flexibility was demonstrated in anti-armor missions. On several occasions, 16 armored vehicles were destroyed on a single sortie by two F-15s carrying eight GBU-12s each.

Issue

- Improving the on-board navigation system will improve system effectiveness and responsiveness. (The NAVSTAR Global Positioning System currently offers the most promising alternative.)

F-16 FIGHTING FALCON MULTI-ROLE AIRCRAFT



Mission

The F-16 Fighting Falcon is the Air Force's primary multi-role aircraft, able to deliver a wide range of air-to-surface and air-to-air weapons. The F-16 was used during Operation Desert Storm for strategic attack, offensive counter air, suppression of enemy air defenses, air interdiction, and close air support.

System Data (F-16C)

Prime Contractor: General Dynamics Corp.
Crew: One Pilot
Initial Operational Capability: 1984
US Inventory: 1759
Length: 49.3 ft
Wingspan: 32.8 ft
Weight: 42,300 lb maximum takeoff
Cruise Speed: High subsonic
Range: 510 to 600 miles (High Profile)
Propulsion: One F110-GE-100 turbofan engine
Armament: Most air-to-air missiles and air-to-surface missiles and bombs

Employment

The F-16's involvement in Operations Desert Shield and Desert Storm began on 10 August with the deployment of 24 F-16Cs to Al-Dhafra, United Arab Emirates (UAE). A second squadron of F-16Cs arrived there the next day. Upon arrival, 12 F-16Cs were reconfigured for air-to-air combat and placed on alert. On 13 August, F-16s from Al-Dhafra, UAE, began flying training and orientation flights as aircraft and weapons continued to arrive in theater. As munition stockpiles built up, additional aircraft were placed on CAS alert to respond to any Iraqi incursion into Saudi Arabia.

From September through January, F-16s continued to arrive in theater. As the units arrived, they trained alongside other Coalition air forces in the Gulf region. F-16s refined established tactics and techniques and developed new procedures tailored to the desert environment. Specific training included medium altitude weapon deliveries and large force operations. Training also included extensive use of air refueling and airspace control procedures. During this time, Low Altitude Navigation Targeting Infrared for Night (LANTIRN) units received a full complement of navigation pods and accomplished Operational Test and Evaluation of this portion of the weapons system while preparing for and executing Operation Desert Storm. The complete LANTIRN system consists of a navigation pod and a targeting pod containing a laser designator, all integrated and mounted externally beneath the aircraft; however, because of the limited number available, no F-16s were equipped with LANTIRN targeting pods.

A total of 251 F-16s participated in Operation Desert Storm, attacking oil refineries, communications facilities, surface-to-air missile sites, Scud facilities, Republican Guard headquarters, airfield facilities, runways, aircraft bunkers, and chemical weapons bunkers. On 19 January, 56 F-16s attacked the Baghdad Nuclear Research Center in the largest single raid of the war. During Operation Desert

Storm, F-16s continued to strike targets supporting all facets of the air campaign from strategic attack to CAS.

During the air campaign, F-16s used a two-aircraft formation as the basic fighting element. This basic two-aircraft element combined with other elements to form flights of four aircraft. These flights of four were then joined with other flights to form strike packages as large as 56 aircraft. In the early stages of the campaign, large packages were routine. However, as air supremacy was gained and targeting priorities changed, F-16s were used more as two-aircraft elements or as flights of four rather than in large packages.

Typical weapons loads used during Operation Desert Storm were:

- six MK-82s (500lb general purpose bomb) or,
- two MK-84s (2000Lb general purpose bomb) or,
- four CBU-52/58/71 (cluster bomb unit, anti-personnel) or,
- four CBU-87 (Combined effects munition) or,
- four CBU-89 (Gator mine, anti-personnel) or,
- four AGM-65 Maverick (electro-optical/IR guided missile) or,
- twoAGM-69/88 (Shrike/high-speed anti-radiation missile)
- 510 rounds 20 mm Armor Piercing Incendiary/High Explosive Incendiary
- two AIM-9Ms

There was a requirement during the conflict for current and accurate target information in the interdiction mission area. This role was filled by F-16s in the Killer Scout mission, which essentially was armed reconnaissance that coordinated air strikes. Airspace was divided in 36x36 mile kill boxes. The Air Tasking Order assigned kill boxes. In the assigned boxes, scouts provided continuous daylight coverage for a two-aircraft formation and located targets in their area. Scouts provided target type and location updates as well as threat status and position information of other friendly aircraft. The intent was to strike assigned targets as soon as possible and keep traffic flowing through the Kuwait Theater of Operations.

Performance

F-16s proved effective when using GPS in conjunction with off-board sensors and LANTIRN.

Infrared Mavericks (AGM-65D/Gs) provided F-16s with a precision weapon that allowed standoff at medium altitude. When used in conjunction with the radar it provided beyond visual range targeting.

Five F-16s were lost in combat.

OBSERVATIONS

Accomplishments

- More than 13,480 combat sorties were flown against targets including airfields, Republican Guard positions and strategic targets near Baghdad.
- F-16s had a mission capable rate of 88.8 percent, and the highest use rate of all USAF aircraft in theater (1.35 sorties per aircraft per day).
- F-16s using GPS, on board radar, and LANTIRN Forward-looking infrared proved successful.

Issue

- The F-16 LANTIRN units are now receiving and qualifying with their targeting pods.

F-111 AARDVARK STRIKE AIRCRAFT

Mission

The F-111 is a land-based supersonic tactical strike aircraft. It has variable sweep wings, a terrain-following radar, a self-contained inertial navigation system and a radar bombing system – a combination that enables low-level attacks in all weather conditions.

Two F-111 models participated in Operations Desert Shield and Desert Storm; the F-111E and the F-111F. The major difference between the F-111E and the F-111F is the F-model's Pave Tack pod which provides an infrared target-acquisition and laser-designation capability to attack point targets in clear weather at night with laser-guided weapons.

System Data

Prime Contractor: General Dynamics
Crew Size: Two; one Pilot, one Weapon System Officer
Initial Operational Capability: 1967 (F-111A)
US Inventory: 79 F-111Es and 83 F-111Fs
Length: 73.5 ft
Wingspan: 32 to 63 feet
Weight: 100,000 lbs maximum takeoff
Speed: 1.2 Mach at sea level
Range: 828 miles (combat radius)
Propulsion: Two Pratt and Whitney TF-30 turbofan engines
Armament: General purpose bombs (MK-82, MK-84), Guided weapons (GBU-10, GBU-12, GBU-15, GBU-24, GBU-28), and cluster munitions (CBU-87, CBU-89)

Employment

The United States used 66 F-111Fs from bases inside Saudi Arabia and 18 F-111Es as part of the EUCOM supported Operation Proven Force based at Incirlik Air Base, Turkey. The first F-111 unit to deploy to the Gulf region was the 492nd Tactical Fighter Squadron (TFS) from Lakenheath Air Base, United Kingdom (UK). The 492nd TFS sent 18 of its F-111Fs to At-Taif, Saudi Arabia, on 25 August 1990. On 2 September, the 493rd TFS deployed 14 of its F-111Fs to At-Taif and on 29 November, the 494th TFS sent 20 F-111Fs to At-Taif. The 495th TFS sent the last F-111Fs from Lakenheath to Saudi Arabia on 11 December.

The 20th Tactical Fighter Wing from Upper Heyford, UK, was participating in routine training exercises at Incirlik Air Base, when tensions were rising between Iraq and Kuwait. The 77 TFS's 14 F-111Es remained in Turkey and represented the only US land-based offensive air capability in the Southern region until F-16Cs arrived in the region on 10 August. The 55th TFS replaced the 77th TFS on 31 August but eventually was replaced by the 79th TFS before Operation Desert Storm began. The 79 TFS remained on station in Turkey and operated as part of the Operation Proven Force composite wing until the war ended.

During Operation Desert Shield, the F-111Fs participated in composite force training missions aimed at increasing interoperability with the other night-capable air assets.

F-111s were tasked to attack airfield aircraft and facilities; hardened aircraft shelters; command, control, communications and intelligence facilities; bunkers, nuclear, biological, and chemical warfare facilities; bridges; air defense assets; and armor. Many of these missions were conducted in adverse weather conditions with an average sortie length of more than three hours. The Pave Tack forward-looking

infrared (FLIR) system proved to be an invaluable asset at night, providing pinpoint accurate deliveries of laser-guided weapons.

Performance

The F-111's long range reduced aerial refueling requirements, freeing these resources to support other missions. The F-111 was used in a non-traditional anti-tank role. The Iraqi decision to deploy armor in fixed target positions allowed these positions to be determined. This enabled the F-111s to detect and attack the dug-in armor using the Pave Tack FLIR in conjunction with laser-guided bombs. The F-111 also demonstrated a capability to attack high-contrast targets with extreme precision when it used the TV-guided GBU-15s to destroy the oil facilities that Iraq used to pump oil into the Gulf.

The F-111 posted an 85 percent mission capable rate. No F-111s were lost during the war and only one sustained battle damage in more than 4,000 sorties.

OBSERVATIONS

Accomplishments

- The F-111's Pave Tack FLIR provided precision weapon capability at night allowing the aircraft to continue bombing round-the-clock. The ability to work at night allowed the F-111 to operate in a reduced threat environment, since electro-optical and infrared guided surface-to-air weapons require visual acquisition.

- The F-111F was credited with hitting the oil pumping manifold off the Kuwaiti coast, thwarting the Iraqi attempt to further spread Kuwaiti crude oil over the Gulf.

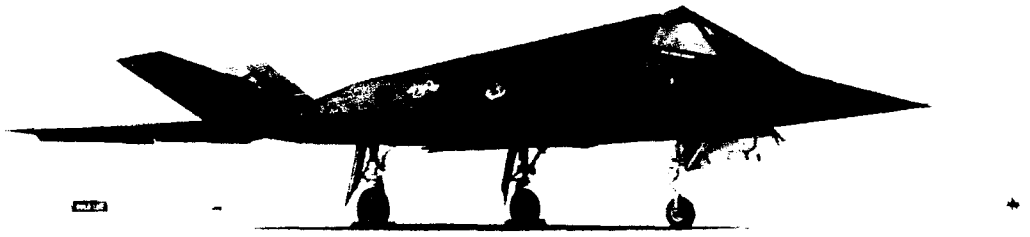
- The Pave Tack system's capability to provide video of the target from acquisition to impact provided immediate feedback for battle damage assessment.

- The F-111F successfully used the GBU-28 laser-guided bomb against a deeply buried command and control facility in Iraq.

Issue

- A planned avionics upgrade will provide a more accurate and reliable INS, especially if integrated with the NAVSTAR Global Positioning System.

F-117A NIGHTHAWK STEALTH FIGHTER



Mission

The F-117A Stealth fighter's mission is to penetrate dense threat environments and attack high-value/high-leverage targets with pinpoint accuracy using conventional laser-guided bombs.

System Data

Prime Contractor: Lockheed Aircraft
Crew: One pilot
Initial Operational Capability: Mid-1980s
US Inventory: 56
Length: 66 feet
Wingspan: 43.3 feet
Weight: 52,500 lbs maximum takeoff
Speed: High Subsonic
Range: 540 to 720 mile combat radius
Propulsion: Two General Electric F404-GE-F102 turbojet engines
Armament: Two laser-guided bombs (LGBs)

Employment

From September through December, the F-117s refined established tactics and techniques and developed new procedures tailored to the desert environment. Training included extensive use of air refueling. In addition to air refueling, training involved mock attacks at night on buildings and structures similar to the potential targets in Iraq.

During the first Operation Desert Storm attack, the F-117s were targeted against the Iraqi Integrated Air Defense System (IADS), specifically the integrated operations centers in the south and west. The F-117's second attack targeted key command and communications (C2) centers in downtown Baghdad. These attacks were designed to quickly isolate field commanders from the decision makers in Baghdad.

On subsequent nights, the F-117s focused their attacks on other target categories to include hardened aircraft shelters at Iraqi airfields; nuclear, biological and chemical warfare research, production, and storage areas; bridges; Scud missile production and storage facilities; as well as the command, control, and communications targets. Before the ground offensive began, the F-117s were tasked to strike the oil pumping stations used by the Iraqis to feed the fire trenches along the Saudi/Kuwait border. The F-117 was effective in this role, removing both a physical and a potential psychological weapon from the Iraqi arsenal.

Performance

The F-117 achieved tactical surprise on the first night of the war, when it attacked about 35 percent of that night's strategic targets. It flew into the highest threat areas and was exposed to these threats for a relatively long time. The F-117 attacks helped disrupt the Iraqi IADS, and destroyed C2 centers in Baghdad.

The F-117 was used by planners to strike the most heavily defended targets in the most populated areas. By virtue of its stealth characteristics, the F-117 allowed operations without the full range of support assets required by non-stealthy aircraft. Typically, F-117 sorties used little or no direct electronic combat or fighter support. These factors allowed planners to attack a far wider array of targets than would have been possible without them.

Over the course of the war, the deployed F-117s flew approximately two percent of the total attack sorties, yet struck about 40 percent of the strategic targets attacked. It was the only aircraft to attack targets in downtown Baghdad and to hit targets in all 12 target categories. The F-117's high accuracy limited collateral damage, particularly in Baghdad. No F-117s were lost or damaged due to air defenses, an outcome which strongly suggests stealth technology was effective.

The mission planning system designed specifically for the F-117 is time consuming and labor intensive.

OBSERVATIONS

Accomplishments

- The F-117 flew 1,296 sorties, mostly against targets in the heavily defended areas of downtown Baghdad, without the loss of a single aircraft.

- The F-117 was a weapons system of choice by planners to attack targets in downtown Baghdad. It struck targets in all 12 air target categories.

Shortcoming

- The F-117 has a slow, tedious mission-planning system.

Issues

- The mission planning system is undergoing a complete revision to make it more user friendly and adaptable to changing conditions. The USAF also is incorporating the F-117A's mission requirements into an upgraded Air Force Mission Support System.

- Improving the on-board navigation system will improve system effectiveness and responsiveness. The NAVSTAR Global Positioning System currently offers the most promising alternative.

F/A-18A/C HORNET STRIKE FIGHTER

Mission

The F/A-18 Hornet strike fighter is a twin-engine, twin-tail, high performance, multi-mission tactical aircraft operated by the Navy and Marine Corps (USMC). The Hornet uses selected external equipment to accomplish specific fighter or attack missions. When used as a fighter, the F/A-18 provides cover for tactical air projection over land and sea and complements Fleet air defense. The primary attack missions are interdiction, close air support, defense suppression, and strikes against land/seaborne targets.

System Data

Prime Contractor: McDonnell Douglas
Crew: One pilot
Initial Operational Capability: 1983 (F/A-18A)
US Inventory: 526
Length: 56 feet
Wingspan: 37.5 feet
Maximum Gross Weight: 51,900 lbs
Speed: 725 kts, 1.8 + Mach
Combat Radius: 440 miles (fighter mission); 500 miles (attack mission)
Propulsion: Two General Electric F404-GE-400 afterburning, low-/ bypass turbofan engines each capable of producing 16,000 pounds thrust
Armament: Nine external stations, including two wingtip stations for AIM-9 Sidewinder air-to-air missiles; two outboard wing stations for an assortment of air-to-air and air-to-ground weapons, including AIM-7 Sparrows, AIM-9 Sidewinders, AGM-84 Harpoons, AGM-88 high-speed anti-radiation missiles (HARM) and AGM-65 Maverick missiles; two inboard wing stations for external fuel tanks or air-to-ground weapons; two nacelle fuselage stations for Sparrows, AN/ASQ-173 Laser Detector Tracker Strike Camera, AN/AAS-38 targeting forward-looking infrared (FLIR) or AN/AAR-50 navigation FLIR; and a center station for fuel tank or air-to-ground weapons. Air-to-ground weapons include GBU-10 and 12 laser-guided bombs (LGBs), MK-80 series general purpose bombs, and CBU-59 cluster bombs. A M61 20-mm six-barrel gun is mounted in the nose and has a director gunsight.

Employment

Ninety Navy F/A-18 A/Cs, operating from four aircraft carriers, participated in Operation Desert Storm combat operations. The multi-mission Hornet was used in all areas of the offensive counter air (OCA) and defensive counter air (DCA) mission. The OCA sweeps were flown in the early days of the war to engage Iraqi aircraft that may have been in the target area. Typical F/A-18 load for this mission was two AIM-9, two AIM-7, and full 20-mm ammunition (FAMMO).

Thirty-six USMC F/A-18A and 36 F/A-18C aircraft deployed to SWA. USMC F/A-18s were used in strategic air strikes, suppression of enemy air defense (SEAD), Republican Guard attacks, battlefield preparation, and air support during the ground offensive. Strikes were launched from Skaikh Isa, Bahrain, with a typical load of two fuel tanks, two Sparrow AAMs, two Sidewinder AAMs, and five MK-83 Rockeye, or MK-84 bombs, or Walleye, or Maverick missiles. F/A-18 also used FLIR and HARM.

Dedicated combat air patrol (CAP) missions were flown around the clock by units in the Persian Gulf to maintain a fighter presence on the three assigned CAP stations. Typical load for this mission was two AIM-9, two AIM-7, FAMMO, and a forward-looking infrared (FLIR) pod.

The F/A-18 Hornet was heavily tasked to conduct SEAD missions during the first part of the war. Normal mission load consisted of two AIM-9, two AIM-7, FAMMO, and two AGM-88 High-Speed Anti-Radiation Missiles (HARM).

OCA airfield attack was conducted by units operating both in the Red Sea and the Persian Gulf. Typical load for this mission was two AIM-9, five or more MK-83s, or two or more MK-84s, one AIM-7, FAMMO and a FLIR pod.

In the airfield attack mission, bunkers and aircraft revetments were attacked with MK-84 bombs with electrically delayed fuzes. Hangers and buildings were attacked with MK-80 series bombs with instantaneous and variable time fuzes. Primary target acquisition systems used were visual, radar, inertial navigation, and FLIR. To remain clear of the Iraqi air defense systems typical attacks were from a 30 degree or greater dive beginning at 30,000 to 35,000 feet with release between 20,000 and 10,000 feet, at an airspeed of 480 to 540 knots.

DCA escort was flown on occasion by units in the Persian Gulf. Typical load for this mission was two AIM-9, one AIM-7, FAMMO and occasionally a HARM.

All aircraft flew with operable electronic countermeasures equipment. This equipment included the ALR-67 Radar Warning Receiver, an ALE-39 chaff/flare dispensing unit, and an ALQ-126B DECM set.

Performance

The F/A-18 Hornet proved highly reliable and survivable. More than 17,500 tons of ordnance were delivered against a variety of targets. Self-escort capability reduced support assets that would otherwise have been required.

The F/A-18 demonstrated exceptional flexibility and rapid turn around times. Its availability was near continuous (99 percent) and its survivability was impressive. Three USMC F/A-18s damaged by surface to air missiles and one by anti-air artillery all returned to base and flew again within 36 hours. Only one Navy F/A-18 was lost in combat.

The successful performance of the multi-mission F/A-18 Hornet was highlighted on 17 January when a division of F/A-18s encountered two Iraqi Mig-21s about 35 miles from the intended target. The F/A-18s acquired, identified, and destroyed the two MIGs, rapidly shifted to the air-to-ground role, rolled in on the assigned target, and dropped MK-84s with pinpoint accuracy

OBSERVATIONS

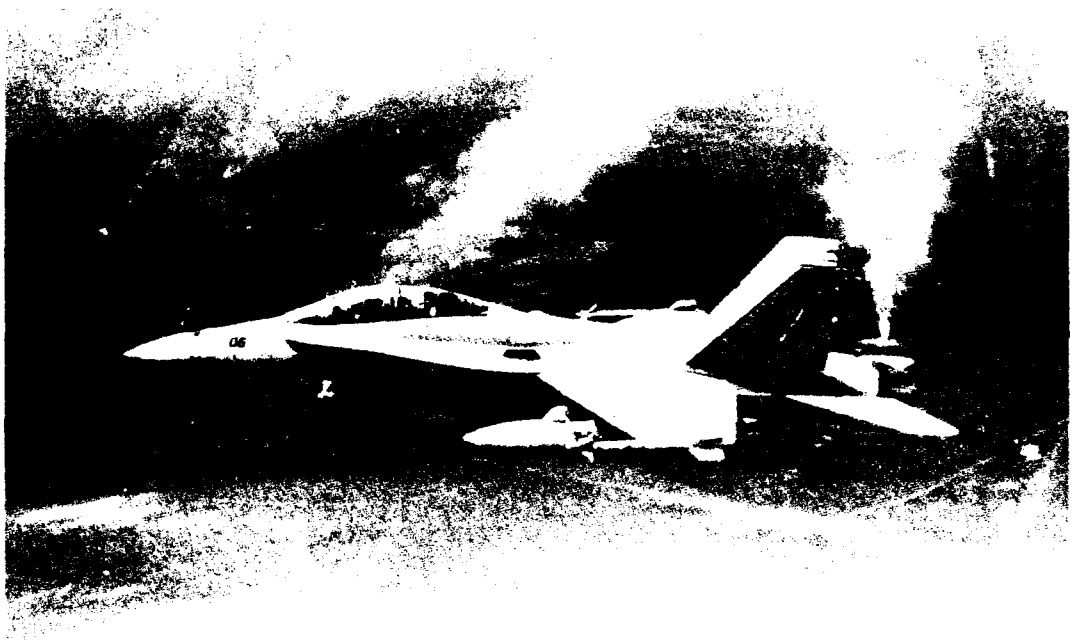
Accomplishments

- F/A-18s were reliable and experienced good survivability in combat.
- Multi-mission philosophy created flexibility for the Operation Desert Storm commander. F/A-18s participated in virtually every conceivable mission during Operation Desert Storm.
- F/A-18s conducted 10 intercepts (established radar contact) against hostile aircraft, with two air-to-air shoot downs.
- F/A-18s demonstrated the capability to acquire strike targets with visual, radar, inertial navigation coordinates and FLIR.

Issue

- Improving the on-board navigation system will improve system effectiveness and responsiveness. The NAVSTAR Global Positioning System currently offers the most promising alternative.

F/A-18D HORNET STRIKE FIGHTER



Mission

This two-seat all-weather, day/night Marine Corps (USMC) aircraft's mission is to attack and destroy surface targets, conduct multi-sensor imagery reconnaissance, supporting arms coordination, and intercept and engage enemy aircraft.

System Data

Prime Contractor: McDonnell Douglas
Crew: One pilot, one weapon system officer
Initial Operational Capability: 1989
US Inventory: 29
Length: 56 feet
Wingspan: 37.5 feet
Maximum Gross Weight: 51,900 lbs
Cruise Speed: high subsonic to supersonic
Combat Radius: 410 miles (fighter mission), 465 miles (attack mission)
Propulsion: Two General Electric F404-GE-400 turbofan engines
Armament: Nine external stations, including two wingtip stations for AIM-9 Sidewinder air-to-air missiles; two outboard wing stations for an assortment of air-to-air and air-to-ground weapons, including AIM-7 Sparrows, AIM-9 Sidewinders, AGM-84 Harpoons, AGM-88 high-speed anti-radiation missiles (HARM) and AGM-65 Maverick missiles; two inboard wing stations for external fuel tanks or air-to-ground weapons; two nacelle fuselage stations for Sparrows, AN/ASQ-173 laser detector tracker strike camera, AN/AAS-38 targeting forward-looking infrared (FLIR) or AN/AAR-50 navigation FLIR; and a center station for fuel tank or air-to-ground weapons. Air-to-ground weapons include GBU-10 and 12 laser-guided bombs, MK-80 series general purpose bombs, and CBU-59 cluster bombs. A M61 20-mm six-barrel gun is mounted in the nose and has a director gunsight

Employment

The USMC deployed 12 F/A-18D aircraft to Southwest Asia. The F/A-18s were used in tactical air coordinator and airborne forward air control roles. These aircraft flew into target areas ahead of Coalition strike aircraft to locate and identify high value targets during tactical air missions. F/A-18s provided almost 24-hour battlefield coverage for close air support (CAS) missions.

Performance

The F/A-18Ds flew 557 sorties and achieved a 14 sorties a day sustained sortie rate. The aircraft's mission capable rate was 85.9 percent. Ordnance expended included 2,325 rockets and 27,000 rounds of 20-mm cannon ammunition.

F/A-18Ds located and identified high value targets not only for USMC tactical air strikes but also for Air Force, Navy and Kuwaiti Air Force strikes.

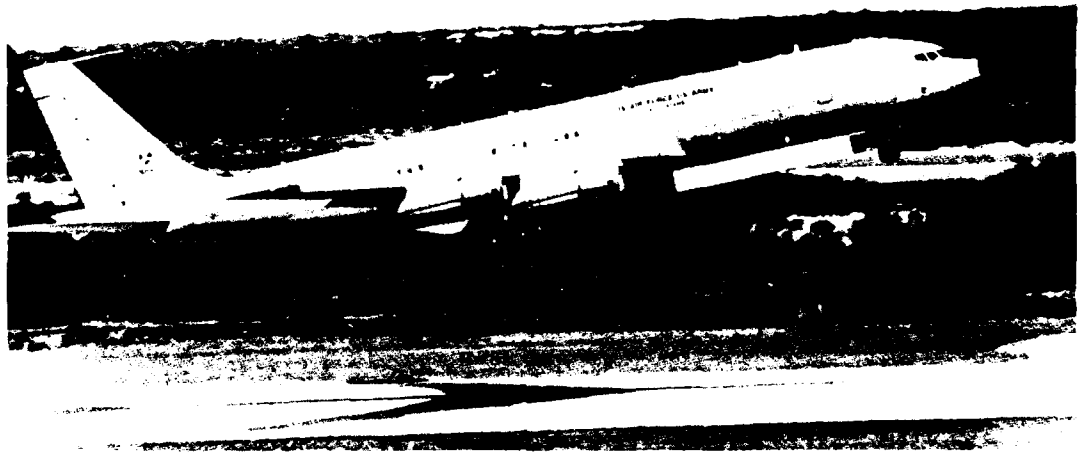
The F/A-18 demonstrated good survivability during Operation Desert Storm. Throughout the air campaign and ground offensive, no F/A-18Ds were lost to enemy fire and only two sustained battle damage (one from a surface-to-air missile and one from anti-air artillery; both returned to service within less than 36 hours) even though the aircraft spent more time in threat areas because of its air control mission.

OBSERVATIONS

Accomplishments

- F/A-18Ds located and identified high value targets for Coalition CAS sorties.
- F/A-18Ds were effective in controlling as many as 20 aircraft in a 30-minute period, providing not only target identification and location, but also threat and overall battlefield updates.

JOINT SURVEILLANCE AND TARGET ATTACK RADAR SYSTEM (JSTARS)



Mission

The Joint Surveillance and Target Attack Radar System (JSTARS) is a joint Army/Air Force (USAF) development program designed to provide near real time (NRT) wide-area surveillance and deep targeting capability to ground and air commanders for indications and warning, situation development, and target development. The USAF is responsible for developing the E-8 aircraft, a military version of the Boeing 707, the airborne radar, the aircraft self-defense suite and air-to-ground communications. The JSTARS radar provides information on both moving and fixed targets.

A frequency hopping, Ku Band surveillance control data link (SCDL) is the primary communications means between the E-8 and ground station modules (GSM). The SCDL provides Ground Station Module (GSM) operators the same radar data available to on-board operators for processing, analyzing, and disseminating to operational and tactical ground commanders. The Army is responsible for developing the GSM.

Interim GSM (IGSM) is a full scale development model. The system will receive, process, and analyze data from several sensors in addition to JSTARS (e.g., Small Aerostat Surveillance System and OV-1D side-looking airborne radar). However, it can operate only with one sensor at a time. Six IGSMs, mounted on five-ton trucks, were deployed.

System Data

Prime Contractor: Grumman Aerospace Corp
Crew: Flight crew of four plus 17 to 25 mission specialists
Initial Operational Capability: Projected FY 97
US Inventory: Two research and development aircraft
Length: 145 ft
Wingspan: 146 ft
Combat Weight: 325,000 lb
Cruise Speed: 480 mph
Range: 3,000 miles
Propulsion: Four TF-33 turbofan engines
Armament: None

Employment

Two E-8s deployed to Riyadh, Saudi Arabia on 12 January and the first operational mission was flown two days later. Six IGSMs were sent to Saudi Arabia, arriving on 12 January. An IGSM was allocated to both Air Force Component, Central Command (AFCENT) and Army Component, Central Command (ARCENT) in Riyadh; one was deployed with Marine Component, Central Command (MARCENT) at various locations; one was sent to ARCENT forward at King Khalid Military City; and one, was assigned to both VII Corps and XVIII Airborne Corps. Only two E-8 missions were flown before Operation Desert Storm began, one primarily for testing. Iraqi ground equipment was detected on both flights.

Performance

Throughout Operation Desert Storm, JSTARS (with external sensor cueing) was able to detect, locate, and track high value targets, such as Scud missile launchers, convoys, river crossing sites, logistics sites, assembly areas, and retreat routes.

On 29 January, JSTARS detected a convoy moving south from the suburbs of Kuwait City. JSTARS tracked the convoy and passed the target to the Airborne Battlefield Command and Control Center, which called in Coalition aircraft. These aircraft reportedly destroyed 58 of 61 vehicles in the convoy. Later that day, during the battle for Al-Khafji, JSTARS confirmed no Iraqi reinforcements were being sent, permitting a rapid and accurate assessment of the tactical situation which helped in plan the JFC-E for the counterattack.

OBSERVATIONS

Accomplishments

- JSTARS proved it could deploy to an area and operate with existing command, control, communications, and intelligence (C^3I) assets.
- JSTARS provided NRT monitoring of major enemy ground movements.
- JSTARS real-time monitoring of Coalition force movement helped coalition force command and control and reduced fratricide.
- Deployment of E-8/IGSM systems still in full scale development (i.e., Initial Operational Capability planned for FY97) worked well and provided significant C^3I contributions.
- JSTARS performed well in combat conditions. Operation Desert Storm re-validated the need for a system to locate and track moving ground targets across a wide area and quickly relay this information to commanders.

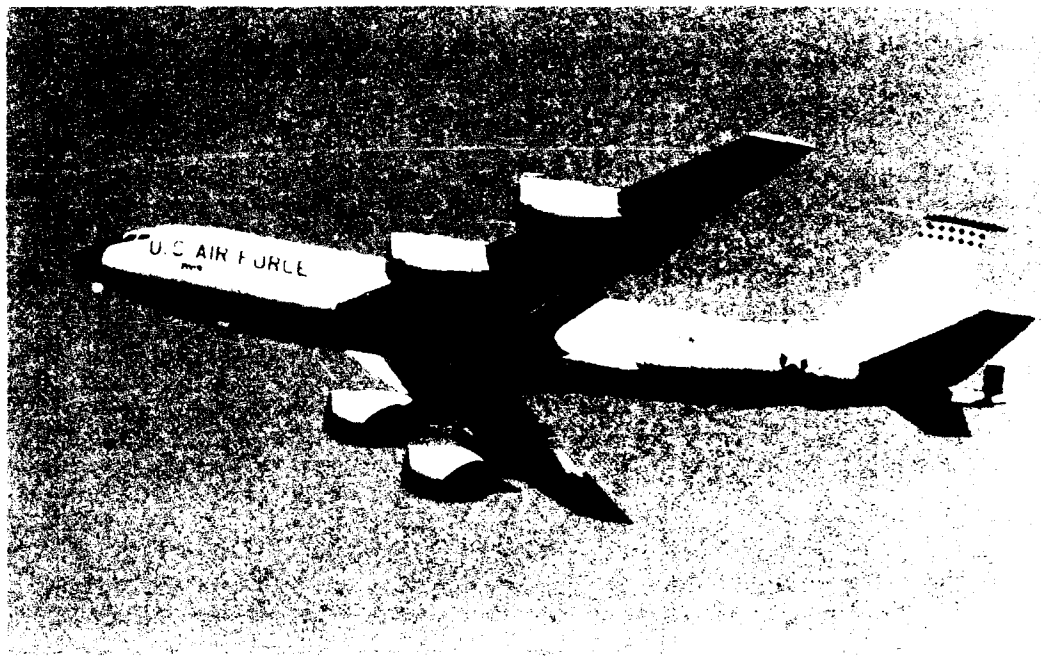
Shortcoming

- The two available JSTARS aircraft could not meet Central Command's requirements. Because JSTARS is a development system, spare parts were at a premium and often had to come from the non-flying platform to meet mission requirements.

Issues

- JSTARS program managers are working with the acquisition community to improve JSTARS support for future contingencies.
- The USAF and Army are reviewing JSTARS concepts of operation with respect to tactical integration of JSTARS and air/ground users.
- Incorporating the NAVSTAR Global Positioning System with on-board navigation will improve system effectiveness and make JSTARS more compatible with intelligence collection systems.

KC-135 STRATOTANKER REFUELING AIRCRAFT



Mission

Purchased to refuel strategic long-range bombers, the KC-135 also provides aerial refueling support to all Air Force (USAF), Navy, and Marine Corps (USMC) aircraft as well as allied aircraft. KC-135s have the additional ability to transport passengers and cargo. There are four variants of the KC-135; the KC-135A, KC-135E, KC-135Q and KC-135R.

System Data

Prime Contractor: Boeing
Crew: Four
Initial Operational Capability: 1957 (KC-135A)
US Inventory: 629; 182 KC-135As, 158 KC-135Es; 235 KC-135Rs; 54 KC-135Qs
Length: 136 ft 3 in
Wingspan: 130 ft 10 in
Maximum takeoff weight: 203,288 lbs (KC-135R), 189,000 lbs (KC-135A/Q), 193,000 lbs (KC-135E)
Cruise Speed: 460 knots
Range: 11,270 miles
Propulsion: Four F108-CF 100 jet engines (KC-135R)
Armament: None

Employment

Tankers established air refueling bridges across the Atlantic and Pacific oceans to move fighter aircraft to the Gulf region. These aircraft also supported airlift aircraft deploying ground units to the region. During the conflict, KC-135 tankers were assigned to specific strike formations.

More tankers were involved in the Gulf War operations than the 230 aircraft identified in Joint Staff plans for regional contingency operations. During Operations Desert Shield and Desert Storm, 262 KC-135s supported the theater along with 46 KC-10s. In addition to refueling sorties, KC-135s flew 913 airlift sorties, transporting passengers and cargo to the theater and within the theater. US tankers refueled aircraft from the armed forces of Italy, Oman, Bahrain, Saudi Arabia, and the United Arab Emirates. The crucial limiting factor affecting air refueling was airspace. A combination of air refueling tracks and anchors were used to maximize tanker availability. Tankers performed some refuelings over enemy territory. The Air Reserve Component (ARC) of the tanker force participated in all phases of operations, comprising 37 percent of the tanker fleet in the theater. Twelve of 13 Air National Guard units and all three Air Force Reserve tanker units were activated.

Performance

KC-135s flew almost 23,000 refueling sorties, delivering more than 136 million gallons of fuel to more than 69,000 receivers. No air refuelings were missed for reasons other than weather. Mission capable (MC) rates exceeded 90 percent which is greater than the peacetime rate.

Aircrew performance, both active duty and ARC, was excellent due to both normal training (including worldwide operations and joint and combined exercises) and the intensive training and flying time expended to hone skills before Operation Desert Storm.

KC-135A and Q model performance was marginal in the hot weather conditions, even with thrust augmentation. This augmentation is provided by 5,500 lbs of water injected into the engines during takeoff. This requirement makes these models dependent on demineralization plants and water trucks and reduces the fuel capacity. The performance of the KC-135A and Q limited their use in Operations Desert Shield and Desert Storm. Missions supported by one KC-135R required two KC-135A or Q aircraft for the same level of support. In addition to performance factors, some beddown locations were unavailable to A and Q models because of noise and/or pollution considerations.

The KC-135 requires installation of a single-point boom drogue adapter before refueling probe-equipped aircraft (Navy, USMC, and certain allied aircraft). Probe/drogue receivers found this fixed attachment on the KC-135 less desirable than the separate hose systems on other tankers because it leaves less margin for error during engagement, refueling, and disengagement. Some refueling incidents resulted in damage to the refueling probe itself, or to the drogue, requiring the mission to abort. The designed hose length, response, and basket configuration mandate proficiency and training in addition to that required for KC-10, KC-130 and KA-6D hose/basket systems.

OBSERVATIONS

Accomplishments

- KC-135s flew almost 23,000 refueling sorties, providing more than 136 million gallons of fuel to more than 69,000 receivers.
- Mission capable rate exceeded 90 percent, greater than the peacetime rate.

Shortcomings

- KC-135A and Q model performance was marginal, limiting their use.
- The KC-135 requires installation of a drogue adapter on its boom before refueling probe-equipped receivers, which limits its flexibility to refuel all types of aircraft.

Issues

- Performance problems associated with the KC-135A and Q models will be corrected by upgrading them to the R model configuration by 1995.
- A program to equip KC-135s with two wing mounted air refueling pods for probe and drogue operations is in research and development with production planned for 1994. This modification would correct the problems associated with refueling aircraft equipped with probes.
- The Navy uses JP-5 jet fuel for carrier operations because it is less volatile than other grades. However, JP-5 was not as readily available throughout the theater. Refueling carrier-based aircraft with grades other than JP-5 caused safety concerns once the aircraft were back on the carriers. This problem could be a constraining factor in future operations and is under review by a joint USAF/Navy review board.

LIGHT AIRBORNE MULTIPURPOSE SYSTEM (LAMPS) HELICOPTER

Mission

Light Airborne Multipurpose System (LAMPS) is an integrated ship/helicopter system. The helicopter uses avionics and electronics to extend the range of shipboard sensors and weapons. Primary missions are anti-submarine warfare and anti-surface warfare (ASUW). Secondary missions include logistics support, search and rescue, and medical evacuation. LAMPS MK I aircraft support FF 1052, CG 27, and NRF FFG 7 class ships as well as DD 963, DDG 993, CG 47, and FFG 7 class ships awaiting LAMPS MK III modifications. LAMPS MK III aircraft support DD 963, CG 47, and FFG 7 class ships. LAMPS MK III ships have mechanical launch and recovery provisions to permit helicopter operations in severe weather.

System Data

	SH-2F (MARK I)	SH-60B (MARK III)
Prime Contractor:	Kaman Aerospace	Sikorsky/IBM
Crew:	Two pilots, one crew	Two pilots, one crew
Initial Operational Capability:	1973	1984
US Inventory:	111	126
Length:	52 ft 7 in	64 ft 10 in
Rotor Diameter:	44 feet	53 ft 8 in
Gross weight:	13,500 lbs	21,700 lbs
Maximum speed:	150 knots	180 knots
Range:	360 miles	500 miles
Endurance:	three hrs	four hrs
Propulsion:	T-58 turboshaft (2)	T-700 turboshaft (2)
Armament:	2 ASW torpedoes M-60 machine gun	3 ASW torpedoes M-60 machine gun

Employment

The Navy deployed 46 LAMPS aircraft (34 LAMPS MK III SH-60Bs and 12 LAMPS MK 1 SH-2Fs). One SH-2F was equipped with a prototype Magic Lantern laser mine-detection system. LAMPS helicopters operated throughout the Persian Gulf, Red Sea, Gulf of Oman, Gulf of Aden, and Eastern Mediterranean Sea performing maritime interception operations (MIO), detection and targeting missions, mine hunting and destruction, explosive ordnance disposal (EOD) team support, special warfare operations, battle damage assessment, combat search and rescue, and coastal surveillance. Joint operations were conducted with Army and British helicopters and Kuwaiti surface combatants. United Nations Security Council sanctions were enforced through hundreds of merchant shipping queries. LAMPS helicopters provided close-in protective machine gun coverage for boarding parties, detected floating and moored mines and worked in direct support of EOD teams conducting mine destruction. SH-60B crews rescued an Air Force F-16 pilot and a Navy F-18 pilot.

LAMPS helicopters were tasked to find Iraqi patrol boats and minelayers, search oil platforms for Iraqi military activity, and monitor the spread of oil caused by Iraq's environmental terrorism.

Performance

During Operation Desert Storm, LAMPS helicopters flew 10,123 hours in 4,102 sorties. The mission capable (MC) rate was 87 percent and the full mission capable (FMC) rate was 80 percent.

OBSERVATIONS

Accomplishments

- Detected and targeted enemy surface threats which resulted in successful coordinated attacks with armed British Lynx and Army OH-58D helicopters.
- Participated in 11 MIO take downs as gunships in coordinated efforts with SEALs aboard SH-3s.
- Visually located many mines.
- Conducted two successful over-water pilot rescues in the northern Persian Gulf.
- Participated in coordinated attacks with SEALs and OH-58D against Iraqi forces on Qurah Island. Two minelayers were destroyed, 67 enemy prisoners of war (EPWs) were taken, and many documents were captured.
- Along with OH-58Ds from *USS Nicholas* (FFG 47), engaged nine oil platforms in the Ad-Dawrah oil fields, taking 23 EPWs.

Shortcomings

- The LAMPS helicopters lack a stand off air-to-surface weapon like the British Lynx's Sea Skua missile.
- The LAMPS helicopters lack adequate visual identification equipment for surveillance and targeting (particularly night vision) and a Global Positioning System for more accurate navigation.

Issue

- The Penguin air-to-surface missile for the SH-60B (Initial Operational Capability FY-93) will provide an air-to-surface standoff weapon capability.

MH-53E SEA STALLION MINE COUNTERMEASURES HELICOPTER

Mission

The primary missions of MH-53E aviation mine countermeasure (AMCM) helicopters are to detect and sweep mines, and to conduct precursor sweeps for surface mine countermeasure forces. AMCM helicopters tow a cable with a

mechanical cutting device which cuts mine mooring cables releasing the mines to the surface. The helicopters also use acoustic and magnetic mine countermeasure (MCM) sleds, which simulate a ship's propellers and magnetic signature, detonating influence mines. Additionally, they tow a side scanning sonar device to locate moored and bottom mines.

System Data

Prime Contractor: United Technologies Sikorsky Aircraft
Crew: Two pilots, and two to five crewmen
Initial Operational Capability: 1988
US Inventory: 30
Length: 99 ft
Rotor Diameter: 79 ft
Weight: 73,500 lbs (maximum gross weight)
Speed: 150 knots
Range: 750 nm
Propulsion: Three T-64-416 engines
Armament: Two 50-caliber machine guns
MCM systems:
- Mk 103 moored sweep
- Mk 104 acoustic sweep
- Mk 105 magnetic sweep
- Mk 106 magnetic/acoustic sweep
- RAYDIST/GPS navigation
- AN/AQS-14 minehunting sonar

Employment

On 7 October, six MH-53 AMCM Super Stallion helicopters arrived in the Persian Gulf on Air Force C-5As. After Operation Desert Storm began, Coalition MCM platform's principal mission was to clear a path to the Kuwaiti coast for naval gun fire support and a possible amphibious landing. After the cease-fire, these platforms platforms cleared port approaches and harbors, including Kuwait City's port.

Performance

The air-transportable AMCM helicopters provided rapid response for MCM operations. Their high speed provided great flexibility during Coalition MCM operations. AMCM helicopters were the preferred platform for shallow water MCM operations. Using the Mk 106 magnetic/acoustic sweep, the helicopters cleared hundreds of square miles of the northern Persian Gulf. AMCM assets swept over thirty mines and coordinated explosive ordnance disposal (EOD) team mine destruction. The AMCM helicopters averaged four missions per day and sustained an average aircraft availability rate of 83 percent.

OBSERVATIONS

Accomplishment

- This was the first operational deployment of the MH-53E helicopter; the AMCM successfully completed their missions.

Shortcomings

- AMCM helicopters did not have a dedicated surface platform to serve as a flight deck and support ship.
- The MH-53E was not certified to conduct night MCM operations.

Issue

- Programs are being considered to provide AMCM with improved Global Positioning System navigation, night certification, airborne neutralization and sweep systems, and electro-optical minehunting capability.
- The AMCM helicopters lacked a dedicated support ship which could provide a flight deck, command and control, logistics, maintenance, and EOD team support.

OH-58D SCOUT HELICOPTER

Mission

The OH-58D is the Army's first true scout helicopter. Its primary missions are reconnaissance, intelligence gathering, surveillance, and target acquisition and/or designation during day or night operations, and in adverse weather.

The OH-58D's mast-mounted sight (MMS) provides day and night target acquisition sensors and a laser rangefinder/designator. The laser designator lets the OH-58D use laser-guided weapons including Hellfire and other precision munitions. The MMS is above the rotor to increase aircraft survivability by allowing the aircraft to hover closer to the ground or behind hills or berms. The OH-58D's highly accurate inertial navigation system permits precise target location information, which can be passed to other aircraft or artillery elements with an automatic target handover system.

In 1987 and 1988, 15 OH-58Ds were modified with air-to-air and air-to-ground weapons. The modifications include Air-to-Air Stinger (ATAS) and Air-to-Ground Hellfire, Hydra 70 rockets, and a .50-caliber machine gun. These aircraft were designated Prime Chance aircraft.

System Data (Prime Chance aircraft)

Prime Contractor: Bell Helicopter
Crew: Two
Initial Operational Capability: 1987
US Inventory: 168
Length: 33.8 ft
Rotor Diameter: 35 ft
Maximum Gross Weight: 5,400 pounds
Speed: 112 knots (cruise)
Range: 324 miles
Endurance: 2.4 hours
Propulsion: 650hp T-703-AD-700
Armament: Prime Chance only; combination of two of the following: ATAS, Hellfire missiles, .50 Caliber Machine Gun, Hydra 70 rockets

Employment

The Army deployed 132 of 168 (79 percent) of the OH-58D combat fleet to Southwest Asia (SWA). The OH-58D was used as a scout and armed reconnaissance helicopter. As an unarmed scout helicopter, it was used primarily to conduct reconnaissance at night and provided intelligence directly to the ground maneuver commander. The OH-58D designated targets for attack aircraft such as the AH-64 with Hellfire. Operating from naval vessels, seven OH-58Ds were used as reconnaissance and attack assets in the maritime campaign.

OH-58Ds also operated with Marine Corps attack helicopters, coordinated fire support, and led Joint Air Attack Team missions with fixed wing attack aircraft. OH-58Ds also designated targets for F-111s, and other fixed-wing aircraft.

In combat engagements, OH-58Ds contributed to field artillery effectiveness by providing aerial observation for standard artillery munitions and terminal guidance for laser-guided Copperhead rounds.

Performance

The Prime Chance OH-58Ds supporting the maritime campaign in the Persian Gulf used Hellfire anti-armor missiles, 2.75" aerial rockets, and .50-cal machine gun, to attack targets, such as fortified oil platforms and Iraqi forces on islands, from stand-off ranges.

Prime Chance OH-58Ds participated in liberating the first Kuwaiti territory in the conflict. Around noon on 24 January, OH-58Ds operating from *USS Curts* (FFG 38) attempted to rescue 22 Iraqis from a sinking minelayer near Qaruh Island. As the helicopters assisted the survivors, Iraqi forces on the Island fired on the helicopters. As the helicopters engaged the island defenses with rocket and machine gun fire, *USS Curts* maneuvered closer to the island and attacked the positions with its 76-mm guns. Navy SEALs from Naval Special Warfare Group 1 landed on Qaruh aboard helicopters from *USS Leftwich* (DD 984). With the OH-58Ds, *USS Nicholas* (FFG 47), and *USS Curts* covering the island, the SEALs reclaimed the island and raised the Kuwaiti flag on Qaruh Island. The Coalition forces captured 67 enemy prisoners of war (EPWs) during the battle and obtained intelligence about Iraqi minefields in the area.

OH-58Ds operated with AH-64s on raids to destroy radar sites and antiaircraft positions. These missions included seeking out and designating targets for AH-64s. Acting as a covering force to provide early warning, OH-58Ds led the 2nd Armored Cavalry Regiment's main effort into Iraq and Kuwait during Operation Desert Storm. While providing aerial observation for field artillery missions, OH-58Ds successfully designated 12 targets which were destroyed by Copperhead artillery rounds. While operating near friendly ground units, the OH-58D guided close air support sorties onto targets with laser designation.

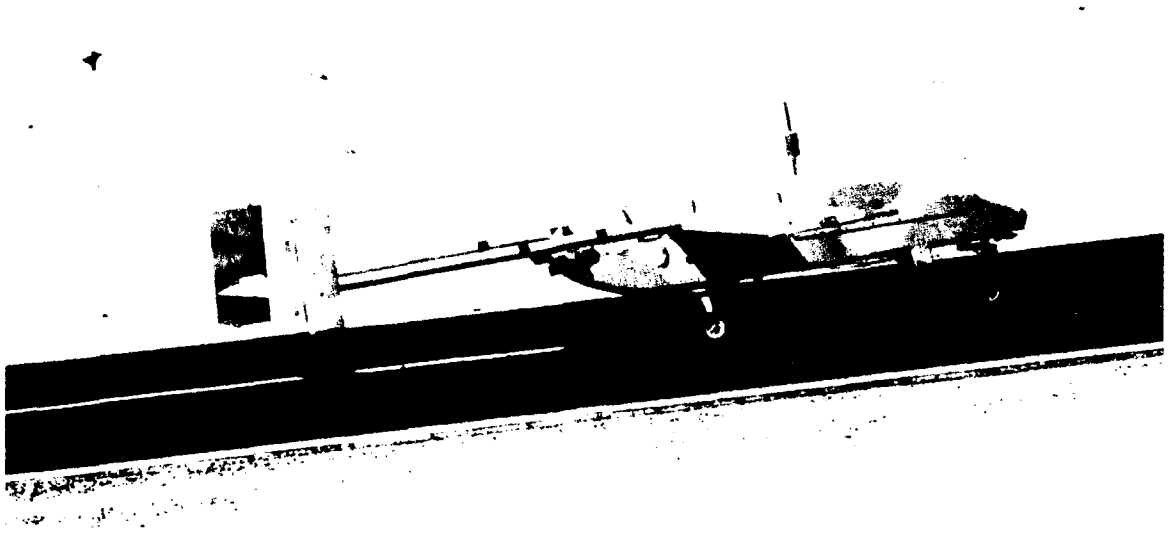
The OH-58D mission capable rate was more than 85 percent. While flying more than 8,700 hours in SWA, the operating tempo exceeded 23 hours an aircraft per month. The normal peacetime operating tempo is 14 hours an aircraft.

OBSERVATIONS

Accomplishments

- Eighty-one percent of the Army's entire OH-58D combat fleet supported operations in SWA. During operations in SWA the OH-58D flew more than 8,700 hours.
- The Prime Chance OH-58Ds were dedicated to joint missions and provided the Navy its only night forward-firing helicopter platform.
- Operating with Naval forces, OH-58Ds participated in liberating the first Kuwaiti territory in the conflict.

PIONEER UNMANNED AERIAL VEHICLE (UAV)



Mission

The Pioneer unmanned aerial vehicle (UAV) system provides near-real time (NRT) day or night reconnaissance, surveillance, target acquisition (RSTA), battle damage assessment (BDA) and battlefield management within line-of-sight of the ground control station. Pioneer systems are used by the Army, Navy, and Marine Corps (USMC).

System Data

Prime Contractor: AAI Corp
Crew: Ground crew, three; flight controllers, three
Initial Operational Capability: 1986 (Interim System)
US Inventory: 50
Length: 14 ft
Wingspan: 17 ft
Max gross weight: 448 lbs
Range: Greater than 120 miles
Mission altitude: 1000 to 12,000 ft
Max altitude: 15,000 ft
Propulsion: 26 horsepower, aviation gas engine
Armament: None
Guidance: UHF/C band telemetry
Sensors: Electro-optical; Infrared, or Television

Employment

The Navy used Pioneer from the battleships *USS Missouri* (BB63) and *USS Wisconsin* (BB64). Pioneer flew 151 sorties for a total of 520 flight hours. Sorties conducted included RSTA, Naval Gunfire Support, BDA, Maritime Interception Operations (MIO) and battlefield management. Information collected was provided to theater and component commanders. For example, as a result of Pioneer, Iraqi patrol boats were detected and a strike on two high-speed boats was directed. In the surveillance role: two Silkworm antiship missile sites were located; 320 ships identified; antiaircraft artillery positions were determined; pre- and post-assault reconnaissance of Faylaka Island was conducted, including the surrender of Iraqi troops; and, major Iraqi armor movements and the retreat from Kuwait were detected.

The Army's Pioneer UAV system is assigned within the UAV Platoon, Fort Huachuca, AZ. This supports the Army's training base and provides a UAV contingency capability for activities such as Operations Desert Shield and Desert Storm.

During Operations Desert Shield and Desert Storm, the Army's UAV platoon was assigned to VII Corps and provided support throughout the Corps area. VII Corps was quick to recognize its value and began requesting more missions than the unit could fly. Targets of interest included tanks, bunkers, command posts, artillery batteries, free rocket over ground (FROG) sites, and convoys. In many instances, the number of targets discovered were so great they could not be engaged quickly. In addition, the Pioneer was used to observe Iraqi retrograde operations.

The USMC used the Pioneer UAV with three Remotely Piloted Vehicle (RPV) Companies operating from Al-Jubai airport, Abu Hadriyah, Al-Mish'ab, and Al-Qarrah.

The USMC Pioneer UAV was used primarily for RSTA. This is because of the current lack of payloads other than electro-optical (day television) and forward looking infrared. One Pioneer vehicle was configured for radio (Very High Frequency/Ultra High Frequency)) relay; however it was not used during the operation. RSTA objectives are to collect information via pre-planned reconnaissance and surveillance, detect, recognize, and identify targets. This information was used to engage targets by gunfire spot adjustment techniques (including naval gunfire) or directing close air support assets toward the target. Targets included troops, tanks, artillery pieces, surface-to-air missile sites (including dummy sites), FROG sites, aircraft hangars, and ground emplacements (trenches, bunkers, supply depots).

Pioneer was an outstanding asset for determining BDA. Its high survivability, long endurance, and NRT video allowed for varying aspect angles and repetitive views during extended periods. The video quality allowed immediate decisions on whether additional attacks were required. For example, a "dummy" SAM site was not engaged because the video allowed the determination that the site was not operational. BDA was performed on the targets previously mentioned.

Performance

The Navy Pioneer UAV system's availability exceeded expectations. Established sortie rates indicated a deployed unit could sustain 60 flight hours a month. During combat operations, units flew more than 125 hours a month. This tempo stretched the current logistic support structure's limits.

Direct control of Pioneer by the Naval tactical commander provided a high degree of responsiveness and flexibility. Airspace deconfliction worked well in the theater of operations. System survivability was well demonstrated. Low signature resulted in only one air vehicle shot down. Three other UAV were hit but were recovered and subsequently repaired and returned to service. During Desert Storm Navy UAVs flew 64 sorties for 213 hours while providing NGFS for 83 missions.

The Army Pioneer UAV provided a quick-fire link that allowed targets to be engaged quickly. The Pioneer helped the tactical commander conduct situation development, targeting, route reconnaissance, and BDA. The UAV platoon also moved during combat to support the forward movement of battle. This was managed by completing a hastily constructed runway near the front line of troops. Army UAVs flew 46 sorties and 155 flight hours during the war.

USMC Pioneer operations were conducted at various altitudes depending on the mission assigned. Marine UAV companies flew 138 missions and 318 hours during Operation Desert Shield and 185 missions and 662 hours during Operation Desert Storm.

OBSERVATIONS

Accomplishments

- Pioneer successfully conducted RSTA, Command and Control (C2), and BDA missions throughout the campaign. Much USMC success in enemy location and validation resulted from hours of UAV video depicting details of exact Iraqi positions.
- Pioneer demonstrated the flexibility to operate from runways and roads.
- Pioneer provided a quick-fire link between real-time video and the shooters.
- Pioneer validated the use of UAVs in the same airspace with manned aircraft.
- Operators provided the first successful integration of ship-based UAVs into combat operations.

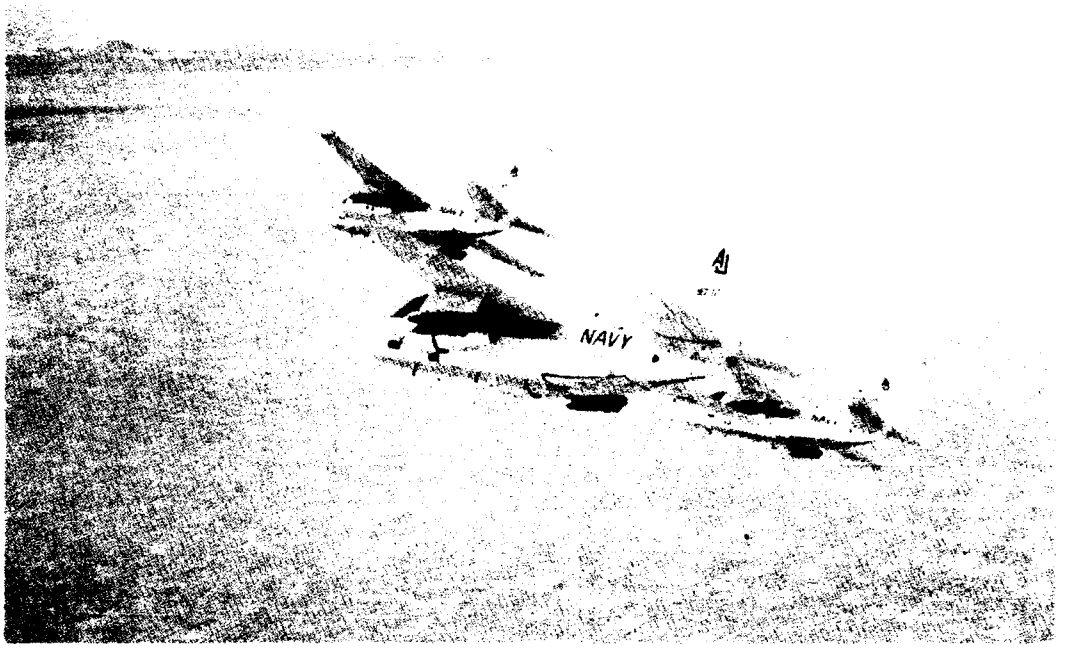
Shortcomings

- Shipboard launch and recovery systems were cumbersome and required increased logistic support.
- The Pioneer UAV uses aviation gasoline which is difficult to obtain and raises safety issues with shipboard storage of the fuel.
- The Army Pioneer's launch and recovery system required a runway. This made use difficult in remote combat areas near the forward line of troops.
- The proliferation of different video formats between Services complicates the sharing of products.

Issue

- The shortcomings are being addressed by the Services in requirements documents in support of future UAVs under development by the UAV Joint Project Office.

S-3B VIKING MULTI-MISSION AIRCRAFT



Mission

The S-3B aircraft is a carrier-based, fixed wing, multi-mission aircraft designed to provide the carrier battle force with a quick reaction outer zone anti-submarine warfare, and anti-surface warfare, surveillance, localization and attack capability. During Operation Desert Storm, the S-3B was used in many additional roles including command and control (C-2) and in-flight refueling.

System Data

Prime Contractor: Lockheed Aircraft
Crew: Four, one pilot and three crewman
Initial Operational Capability: 1974 (S-3A); 1988 (S-3B)
US Inventory: 78
Length: 53.4 feet,
Wingspan: 68.7 feet
Weight: 52,540 lbs maximum takeoff
Maximum speed: 457 knots
Range: 3,168 miles (unrefueled)
Propulsion: Two G.E.TF-34 Turbofan engines
Armament: Harpoon, Mk-80 series bombs, MK-46 Torpedo, all naval mines

Employment

Forty-one S-3 aircraft in theater operated from five aircraft carriers; they flew 1,674 sorties and 4,948 hours supporting Operation Desert Storm. The S-3 multi-mission capability was demonstrated throughout the conflict in a variety of missions:

S-3Bs participated in armed scout missions in the Red Sea and Persian Gulf augmenting armed surface reconnaissance aircraft assigned to strike missions.

S-3 aircraft provided inflight refueling to Combat Air Patrol (CAP) aircraft in the Red Sea and Persian Gulf. Combat tanking was provided to returning strike aircraft. The S-3 provided recovery and emergency fuel for long-range strike aircraft returning to ship. The S-3's extended range and endurance was ideally suited for this mission.

S-3B aircraft smoothed transition and established communication connectivity for strike leaders going to targets in western and central Iraq and the Kuwait Theater of Operations (KTO). S-3B aircraft provided C2 backup when E-2C aircraft were unavailable.

S-3B aircrews also flew SEAD missions in the KTO during the early days of the war.

S-3 aircraft were tasked with transfer of crucial personnel to and from the Fleet and Central Command (CENTCOM) headquarters. Additionally, the S-3 was used to deliver the air tasking order (ATO) from CENTCOM headquarters to the carrier battle group commanders at sea.

Performance

S-3B aircraft provided command, control and communications links among controlling agencies, strike leaders and the battle group commander during strikes. Targets in western and central Iraq and the KTO required crossing most of Saudi Arabia for Red Sea based aircraft. Coordination was required through three USAF AWACS sectors. S-3Bs improved transition and established communications to and from the areas for the strike leaders.

S-3Bs participated extensively in Maritime Interception Operations (MIO) in both the Red Sea and Persian Gulf. A total of 530 sorties was devoted to reconnaissance and interception operations.

As an adjunct to MIO, S-3Bs flew armed scout missions.

S-3Bs flew 68 sorties in support of Persian Gulf MCM.

S-3B aircraft flew 80 sorties dedicated to Counter-Counter targeting/antisurface missile defense.

S-3Bs provided aerial refueling to battle group organic assets in both the Red Sea and Persian Gulf. A total of 562 dedicated tanker missions was flown and an additional 482 sorties provided fuel to fighter and attack aircraft. Missions included tanking for CAP aircraft in the Red Sea and Persian Gulf, overhead recovery tanking, and emergency tanker support. The S-3B provided a tanker hose multiplier to the battle group commander.

The S-3B provided crucial logistic support to the battle group commander. The S-3B was the only reliable platform for delivering the daily air tasking order from Saudi Arabia to the battle group commanders. Additionally, the S-3B provided fast reliable transportation of crucial staff personnel between CENTCOM headquarters and the battle groups.

OBSERVATIONS

Accomplishments

- The S-3B provided effective C2 to strike leaders in SEAD and overland strike missions.
- The S-3B located and identified many surface contacts in a maritime interception role.
- The S-3B provided vital organic tanking capability to battle group aircraft.

SH-3H SEA KING MULTI-MISSION HELICOPTER

Mission

The SH-3H aircraft is a carrier-based, multi-mission antisubmarine warfare (ASW)/fleet support helicopter designed for inner zone ASW protection to the carrier battle group. The SH-3H also can conduct missions involving combat search and rescue (CSAR), naval special warfare (NSW), visual mine search and destruction, anti-ship missile defense (ASMD), surface surveillance and logistics support.

System Data

Prime Contractor: Sikorsky Aircraft
Crew: Two pilots, two door gunners/rescue swimmers
Initial Operational Capability: 1961 (SH-3A)
US Inventory: 113 SH-3Hs
Length: 73 ft
Rotor Diameter: 62 ft
Weight: 21,000 lbs
Maximum speed: 120 knots
Range: 650 miles
Endurance: 5.5 hours
Propulsion: Two T58-GE-10/T58-GE-402 engines
Armament: Two M-60D machine guns
Avionics Systems: Night vision goggle (NVG) compatible cockpit kits; AQS-13E active dipping sonar;AN/ASQ-81 magnetic anomaly detection system (MAD); sonar data computer, AKT-22 Acoustic Data, Link, ARS-6 downed aircrew locating system (DALS)

Employment

Thirty-nine SH-3H helicopters were deployed from one reserve and six active squadrons; 34 aircraft were embarked on six aircraft carriers, two were forward deployed aboard a Spruance class destroyer at a CSAR station in the North Persian Gulf and three reserve helicopters were stationed outside the Gulf. Since Iraq was not considered an ASW threat, the ASW equipment was stripped from SH-3H aircraft to provide more logistics capability.

The SH-3H was reconfigured with additional troop seats and armed with M-60D machine guns to support the following operations:

- Maritime Interception Operations (MIO) – SH-3H aircraft provided transport for boarding teams and insertion of SEAL teams for takedowns of non-cooperative merchant vessels in support of the United Nations embargo. Eleven non-cooperative take downs were conducted.

- Surface Surveillance – Day and night surveillance of surface shipping using stabilized binoculars and NVGs to visually identify contacts of interest. Additionally, visual surveillance of oil slick boundaries was conducted.

- Combat Search and Rescue – A two-aircraft detachment was maintained aboard a destroyer forward deployed to the northern Persian Gulf. Aircraft were airborne or on deck in an alert status and were tasked to support returning strike aircraft.

- Logistics Support – Around-the-clock logistics support consisted of cargo and personnel transport throughout battle force and ashore.

- Mine Detection - Visual searches were conducted for floating mines and Explosive Ordnance Detachment (EOD) or SEAL team members were inserted to destroy them. Twenty-three mines were destroyed in this fashion.

Performance

Aircraft use was 94.9 hours a month. The six embarked squadrons logged 5,781 hours maintaining 81 percent full mission capable (FMC) and 84 percent MC rates. The lack of an ASW threat allowed significant diversification of the missions that the SH-3H could perform for the battle force.

OBSERVATIONS

Accomplishments

- SH-3 helicopter insertions of SEAL teams onto non-cooperative merchant shipping proved to be a crucial element of the MIO. SH-3s also inserted SEAL teams, who captured two islands and a fortified oil platform.

- Although SH-3s normally operate from aircraft carriers, an SH-3 SAR detachment was successfully deployed aboard a destroyer in the northern Persian Gulf.

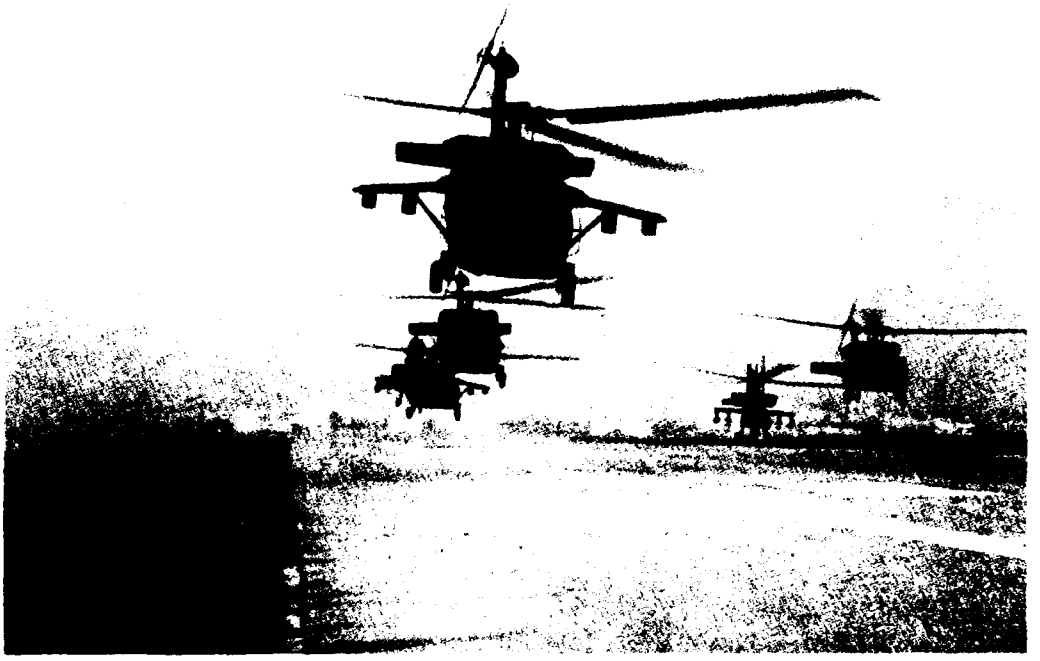
- Eighty-five EPWs were transported to custody.

- Twenty-three mines were sighted by SH-3s and destroyed by EOD teams.

Issue

- Replacement of the SH-3H by SH-60F ASW helicopters plus HH-60H CSAR/NSW helicopters began in 1990. The first airwing outfitted with this configuration arrived in the Persian Gulf three weeks after the end of the conflict. This combination should correct the deficiencies cited above with the exception of sensors and forward firing weapons.

UH-60 BLACK HAWK UTILITY HELICOPTER



Mission

The UH-60 Black Hawk is the Army's primary assault helicopter, able to transport a combat-equipped infantry squad of 11 soldiers, or an external cargo load of up to 8,000 pounds. It transports troops and equipment into combat, resupplies the troops while in combat, performs aerial medical evacuation (MEDEVAC), search and rescue, and command and control (C2). Special Black Hawk variants perform electronic warfare (EH-60) and support special operations missions (MH-60A and MH-60K).

The Black Hawk is replacing the UH-1 Iroquois in assault helicopter companies, cavalry squadrons, attack helicopter battalions, MEDEVAC units, special operations units, and aviation maintenance companies.

System Data

Prime Contractor: Sikorsky Helicopter Company
Crew: Two pilots and one crew chief/gunner
Initial Operational Capability: 1976
US Inventory: 1061
Length: 57.4 ft
Rotor Diameter: 53.7 ft
Maximum Gross Weight: 20,500 pounds; useful payload: 3,500 pounds
Maximum External Load: 8,000 pounds
Maximum Speed: 145 knots (cruise)
Range: 396 miles (803 miles with External Stores Support System (ESSS) and Extended Range Fuel System (ERFS)
Mission Endurance: 2.3 hours (5.4 hours with ESSS and ERFS)
Propulsion: Two T700-GE-700C engines,
Armament: Two M60 machine guns (7.62mm)

Employment

The Army deployed 489 Black Hawks to Southwest Asia (SWA), which is 46 percent of the total inventory. Eighteen UH-60 assault companies were deployed. Additional UH-60s deployed with MEDEVAC units, cavalry squadrons, maintenance companies, AH-64 Apache battalions, and special operations units.

These helicopters performed combat, combat support, and combat service support missions, logging more than 44,000 hours. UH-60s were used for artillery deployment and emplacement, evacuation of enemy prisoners of war, and support of OH-58D's conducting Persian Gulf operations. UH-60s also performed many MEDEVAC missions, including the transportation of patients to and from hospital ships.

The extended range fuel system (ERFS) was particularly beneficial in providing additional range required to operate within the area of operations. UH-60s routinely transported soldiers, equipment, repair parts, supplies, food, and water between unit locations.

Seventeen UH-60s had the new AN/ASC-15B C2 console installed. The airborne C2 consoles provided secure very high frequency, ultra high frequency, frequency modulation, high frequency, and tactical satellite (TACSAT) communications, allowing commanders to maintain control of fast paced operations over extended ranges.

The 101st Airborne Division (Air Assault) conducted the largest air assault in history using 60 UH-60s and 30 CH-47s simultaneously to air assault soldiers and combat equipment to the Euphrates River Valley. This operation established blocking positions preventing the withdrawal of the Iraqi ground forces.

Performance

The UH-60 is a vast improvement from the UH-1. Its highly survivable airframe provides the ground commander the capability of transporting a useful load (internal and external) in a high altitude or hot environment. There were only two UH-60 combat losses.

The UH-60 mission capable rate was 82 percent. It was, however, affected by the sand. The UH-60 made multiple landings and takeoffs in the desert while conducting sling-load operations that required hovering for prolonged periods of time. These operations caused the aircraft to be exposed to excessive sand blasting and sand ingestion. Engines, auxiliary power units, rotor blades, and pitch change rod end bearings were the primary components susceptible to damage.

From a systems capabilities standpoint, the aircraft had insufficient navigational equipment. Due to a lack of identifiable terrain, the crew was unable to update the doppler navigational system. Global Positioning System (GPS) will solve this shortcoming.

In addition to aircraft and systems capabilities shortfalls, additional training was required using night-vision goggles (NVG). Acclimation to the desert environment took time and training. Lack of terrain definition caused the crews to fly higher and slower. Limited definition with night-vision goggles restricted sling-load operations at night.

OBSERVATIONS

Accomplishments

- UH-60s flew more than 44,000 hours supporting operations in SWA and were used in the largest air assault in history.
- UH-60 demonstrated extreme flexibility and versatility by supporting air assaults, MEDEVAC, C2, special operations, electronic warfare, and EPW evacuation.

Shortcomings

- Precision navigation was difficult in the featureless terrain environment.
- Communications during low-level operations was extremely difficult across extended ranges.
- Complete aircraft survivability equipment are not installed fleet wide.
- The aircraft suffered from sand and harsh environmental factors present in a desert environment. Rotor blades, engines and oil coolers were affected by sand erosion.
- Flight in low-light conditions was extremely difficult.

APPENDIX T. Performance of Selected Weapon Systems

GROUND SYSTEMS

ASSAULT AMPHIBIAN VEHICLE (AAV)

AAVP7A1

Mission

The Marine Corps (USMC) AAV7A1 family of vehicles carry the surface assault infantry elements of the landing force and their equipment from amphibious ships to inland objectives. Once ashore, the AAV7A1 family of vehicles supports maneuver warfare and performs combat support (CS) and combat service support (CSS) missions as appropriate. There are three AAV variants:

The **AAVP7A1** is the baseline variant and the primary means of providing armored protected mobility to the Marine Air/Ground Task Force Ground Combat Element. Following closely behind tank units, the AAVP7A1 provides suppressive fires against enemy infantry and lightly armored vehicles. The AAVP7A1 carries infantry forward to maintain an attack's momentum; they dismount and remount as the tactical situation requires. Although optimally

used as a troop carrier in tactical situations, the AAVP7A1 can be called upon to support CSS efforts as a logistics carrier. It also can be configured with special countermine systems to conduct hasty and deliberate minefield breaching operations.

The **AAVC7A1** is used as a mobile command post for infantry regiment and battalion commanders during ship-to-shore movement and operations ashore. It provides the commander with the ability to communicate with combat, CS and CSS units.

The **AAVR7A1** provides recovery and field maintenance support for the AAV7A1 family of vehicles during operations ashore. The AAVR7A1 can recover other AAVs or smaller vehicles. It provides an overhead crane capability to remove AAV power packs and provides equipment and tools for organizational maintenance in the field.

System Data

Prime Contractor: FMC Corporation
Crew: Three
Initial Operational Capability: FY 1985
US Inventory: 1,153
Weight: 57,000 pounds
Load Capacity (maximum): 21 combat equipped Marines or 10,000 pounds of cargo
Cruising Range: Land at 25 mph: 300 miles, Water at 2,600 rpm: 7 hours
Cruising Speed: Land: 20-30 mph, water: 6 mph
Surfability (combat loaded): Able to negotiate 6-foot plunging surf combat loaded and survive 10-ft plunging surf
Armor: 1.4 to 1.75 inches of aluminum armor plate
Armament: M85 .50 caliber machine gun in the electric drive turret, or the Mk 19, MOD 3 40-mm machine gun and M2HB .50 caliber machine gun

Employment

AAVP7A1s were used to provide high-speed, armor-protected mobility to the maneuver elements of the ground forces, along with providing fire support for embarked infantry. The AAVP7A1s also were used extensively as host vehicles for the special mission kits used during minefield breaching, carrying line charges and combat engineer teams.

AAVC7A1s were used as the principal command and control (C2) vehicle by the maneuver element commanders to communicate with subordinate units and higher headquarters. These commanders also used the AAVC7A1 to coordinate fire support and logistics support.

AAVR7A1s were used to provide battlefield maintenance repairs in support of the AAV family of vehicles and for battlefield recovery of AAVs.

During Operation Desert Storm, 473 AAVP7A1s, 40 AAVC7A1s, and 19 AAVR7A1s were used. Aboard amphibious task force shipping, an additional 93 AAVP7A1s, six AAVC7A1s, and four AAVR7A1s were deployed.

Performance

Despite suspension and power shortfalls, the AAVP7A1 proved very reliable in the desert environment. The vehicle met all standards and specifications. AAVP7A1 availability exceeded 93 percent.

The AAVC7A1 proved effective in the desert environment, although some overheating of the vehicle's communication systems was experienced. The vehicles were used extensively for C2. The vehicle met all minimum standards and specifications. AAVC7A1 availability exceeded 95 percent.

The AAVR7A1 proved very reliable in the desert environment. The vehicle exceeded standards and specifications. AAVR7A1 availability was 100 percent.

The firing sights for the M85, Mk 19 and M2HB machine guns were visual only, with no night or low visibility capability beyond what the gunner could see. During low visibility and darkness, the AAV7A1 vehicles were unable to engage targets effectively beyond visual range, and often engaged targets well below the machine gun's maximum effective range.

The AAV7A1's suspension system was over stressed, limiting its cross-country mobility and speed because of the added weight of several production improvements and special engineer mission kits, coupled with life cycle fatigue. Similarly, stress was placed on the propulsion system. This was an important factor in the AAVs' inability to keep pace with the main battle tank.

The AAV7A1 family of vehicles' amphibious capabilities were not tested under combat conditions. However, amphibious planning identified the AAV7A1 family's short range and lack of open ocean capability as limitations in planning over-the-horizon assaults.

OBSERVATIONS

Accomplishments

- All variants performed to mission standards.
- Performance in the desert environment was satisfactory.
- The overall AAV availability rate was 96 percent.

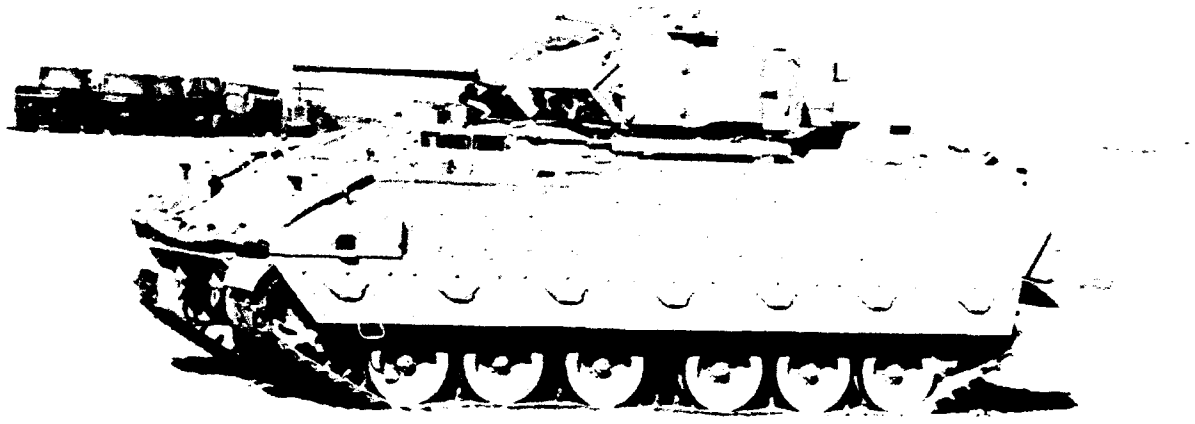
Shortcomings

- AAVs lacked an adequate sight capability and precision onboard navigation equipment.
- AAVs were unable to keep up with the main battle tank while traveling cross-country in the desert terrain.

Issues

- The most widely proclaimed deficiency was the lack of an adequate sighting device for night fighting. The vehicle could not sight to its weapons systems' maximum effective ranges. Potential solutions are being reviewed.
- The suspension system problem was identified before Operation Desert Storm and is being corrected under a funded product improvement program. An advanced propulsion system initiative is being reviewed.
- The flat, featureless terrain made precision land navigation and position locating difficult. During reduced visibility, navigation capability was further degraded. This deficiency is being corrected through the planned procurement and fielding throughout the USMC of a Global Positioning System and the Position Location Reference System. Provisions for installation of this equipment in the AAV were funded in FY 92. These product improvements will correct the most significant deficiencies in its ground support role.

BRADLEY FIGHTING VEHICLE



Mission

The Bradley Fighting Vehicle provides mechanized infantry, armored cavalry, and scout units with a full-tracked, lightly armored fighting vehicle with the mobility, lethality, and survivability to operate with the M-1 tank as a member of the combined arms team.

There are two Bradley variants:

M2 Series Infantry Fighting Vehicle (IFV) - The M2 Bradley provides tactical mobility, limited armor protection, and antiarmor capability to the infantry squad, whose mission is to close with and destroy the enemy. The addition of improvements to the vehicle have resulted in four models: the basic model (A0), A1(-), A1, and A2.

M3 Series Cavalry Fighting Vehicle (CFV) - The M3 Bradley provides tactical mobility, limited armor protection, and antiarmor capability to the scout squad, whose mission is to conduct screening, reconnaissance, and security missions. As with the M2 Bradley, there are four M3 models: the basic model (A0), A1(-), A1, and A2.

System Data

Prime Contractor: FMC Corporation
Crew: Nine-man Infantry squad (three are vehicle crew) (IFV); five-man Scout Section (three are vehicle crew) (CFV)
Initial Operational Capability: 1984
US Inventory: 5,774
Weight (Combat Loaded): 50,000 lbs (A0/A1(-)/A1 models); 60,000 lbs (A2 model) 66,000 lbs (A2 with add-on armor tiles)
Length: 21.5 ft
Height: 9.75 ft
Width: 10.5 ft
Engine: Cummins VTA 903-500 HP Diesel (A0/A1(-)/A1); Cummins VTA 903-600 HP Turbo Diesel (A2)
Maximum Speed: 41 mph (A0/A1(-)/A1); 38 mph (A2)
Cross Country Speed: 30-35 mph
Fuel Capacity: 175 gallons diesel or JP-8
Cruising Range: 300 miles (A0/A1(-)/A1), 275 miles (A2)
Main Armament: M242 25-mm cannon
Secondary Armament: M240C 7.62-mm coaxial machine gun, two-tube (Basic) TOW missile launcher (A0/A1(-)), two-tube TOW2 (T2SS) missile launcher (A1/A2), Six M231 5.56-mm firing port weapons (M2A0/M2A1(-)/M2A1only), Two M231 5.56mm firing port weapons (M2A2 only)

Employment

Units initially deployed to the Persian Gulf were largely equipped with the basic model Bradley. Recognizing the threat posed by Iraqi weapon systems, the Army opted to modernize the fleet in theater. Six hundred ninety-two A2 models were shipped from new production and POMCUS stocks to support this effort. The A2 version's survivability is improved with add-on armor, an interior spall liner, larger engine, and improved ammunition storage. Of the 2,200 Bradleys in theater during the ground campaign, the A1 and A2 models comprised 33 percent and 48 percent, respectively.

Fighting Vehicles complemented tanks in providing anti-armor lethality and high speed maneuver in the offensive. In the heavy force, these systems were generally in the spearhead of the high speed maneuver that took Coalition forces deep into the enemy's rear areas to defeat the Republican Guard and cut off avenues of supply and avenues of withdrawal.

Performance

Division-level after action reports indicate the Bradley fleet maintained an availability rate of more than 90 percent through the 100 hours of high-speed ground war. Units completed long-distance, cross-country movements (100 to 300 miles) with no major breakdowns. While some success may be attributed to the fact that many vehicles were new, consistent performance of operator level Preventive Maintenance Checks and Services was crucial to desert operations. Soldier interviews provide favorable comments on ease of maintenance, reliability of transmissions, and engine power.

Thermal imaging systems (TIS) allowed crews to acquire and engage targets at long ranges through smoke and sand, both day and night. TOW engagement ranges of 2,500 to 3,500 meters were common. The Bradley's 25-mm cannon also was rated by crews as accurate, effective, and lethal. High explosive and armor piercing rounds were effective against light armor, trucks, and bunkers at maximum ranges. However, the lack of a laser range finder was identified as a deficiency. TOW gunners had difficulty determining if targets were within range. When firing the 25-mm gun, lead and elevation became a matter of guesswork, since exact ranges were unknown. Higher resolution thermal sights also are needed to provide better target identification capability at long range.

The Bradley A2 model's survivability improvements proved effective as evidenced by several examples of vehicles which took significant hits without flash fires or catastrophic loss. Most damage was found to be penetrator related with little damage from spall. Unless combustibles or ammunition were in the penetrator path, there was very little collateral damage. Fire-suppression systems worked extremely well. The Bradley's mobility and ability to detect and kill enemy targets before they could respond also contributed to the Bradley's survivability. However, the fact that fire from friendly forces caused more Bradley losses than enemy fire confirms the need for a combat vehicle identification system to prevent fratricide.

Other deficiencies were identified during interviews with vehicle crews and commanders. Without positional navigation devices, land navigation in the desert would have been extremely difficult. Because of the Bradley's current configuration, vehicle exhaust tended to blow into the vehicle commander's face. Stowage capacity for individual equipment aboard the Bradley was inadequate. Support and command and control (C2) vehicles had difficulty maintaining pace with maneuver forces.

OBSERVATIONS

Accomplishments

- Used successfully with the M-1 tank in fast paced, complex offensive and defensive operations.
- Operational readiness rate exceeded 90 percent throughout the campaign.
- Thermal sights provided day and night, all weather target acquisition.
- The TOW II missile and 25-mm cannon were accurate and lethal.
- Survivability validated modernization efforts.

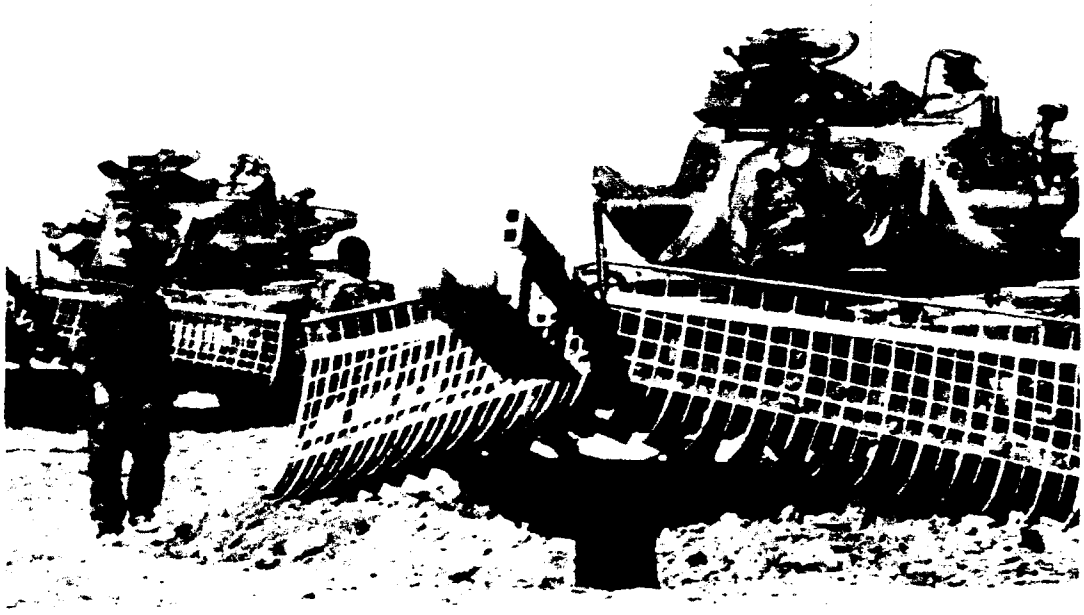
Shortcomings

- Gunnery accuracy was hindered by lack of a laser range finder.
- Detection, recognition, and identification of targets were hindered by lack of high resolution thermal sights.
- The M-2/3 lacks a combat vehicle identification capability and an onboard vehicle navigation device.
- Vehicle exhaust should be redirected away from the commander's hatch.
- Equipment storage capacity is inadequate.

Issue

- Action is under way to resolve identified shortcomings. The crisis occurred midway through the Army's modernization program. As the A2 model is fielded to deployable units, it will be less likely the basic model will deploy. Requirements are being developed to resolve other deficiencies. Efforts are under way to develop a solution for all combat vehicles to improve combat identification and avoid fire from friendly forces. The Army also is considering the second generation forward looking infrared to enhance TIS resolution. Finally, the Army is considering an upgrade program for its fleet of C2 and support vehicles which would improve their ability to maintain pace with the maneuver forces.

LAND MINE COUNTERMEASURE AND OBSTACLE BREACHING SYSTEMS



Mission

Land mine countermeasure (MCM) and obstacle breaching systems are used by combat engineers to breach both man-made (e.g., minefields and tank ditches) and natural obstacles so ground forces can maneuver. Of critical importance during Operation Desert Storm were MCM systems. Selected MCM systems used by the US Marine Corps and the US Army were:

Anti-Personnel Obstacle Breaching System (APOBS): This portable system is an explosive item and is used to breach a continuous footpath (0.6 x 45 meters) through anti-personnel minefields and associated wire obstacles during an assault. It can neutralize single impulse type anti-personnel mines.

M58 Single Shot Line Charge/Mine Clearing Line Charge (MICLIC): This explosive line charge is mounted on a trailer towed by an armored or wheeled vehicle, and is rocket-propelled across a suspected minefield. It is used to breach a continuous path (8m by 100 m) through minefields containing single impulse, non-blast-hardened pressure mines and associated wire obstacles.

Mk 154 Triple Shot Line Charge: This system consists of three individual explosive line charges mounted on an Assault Amphibian Vehicle (AAV). It can clear an 8 by 300 meter area of single impulse, pressure-actuated mines and is capable of waterborne or land use.

Track-Width Mine Roller (TWMR): The TWMR consists of two reinforced, weighted roller devices which are extended in front of the tracks of the tank on which it is mounted. The system activates single impulse, pressure fuzed mines in its path. Its primary purpose is to detect the limits of a suspected minefield or expediently verify a mine cleared lane.

Full-Width Mine Rake (FWMR): The FWMR is mounted on the dozer blade of the M-60 tank or M728 Combat Engineer Vehicle (CEV). It can clear surface and buried mines (12 inches deep) in sandy soils across the full-width of the armored vehicle's path. It physically moves mines to the side and has the advantage of clearing the full-width of the lane.

Other systems used by the US Marine Corps and the US Army to breach obstacles other than minefields were:

M-9 Armored Combat Earthmover (ACE): This system is a highly mobile, survivable, tracked and armored earthmover. It provides a capability to perform offensive and defensive excavation missions without requiring a heavy transporter to move between sites.

M728 Combat Engineer Vehicle (CEV): The CEV consists of a basic M60A1 tank with a hydraulically operated debris blade, 165mm turret mounted demolition gun, retractable boom and winch. It provides engineers in the forward combat area with a versatile, armor-protected means of clearing rubble, filling tank ditches, and a reduction of defended strongpoints. During Operation Desert Storm it mounted the FWMR for the US Army forces.

Armored Vehicle Launched Bridge (AVLB): The AVLB is a standard M48 or M60 tank chassis modified (turret and weapons removed) to transport, launch and retrieve a 60 foot span Military Load Class 60 bridge. It is used to span short gaps (e.g., tank ditches) during an assault, without exposing personnel to direct small arms fire.

Pipe Fascines: This system is an expedient, inexpensive method to cross anti-tank ditches or other gaps up to 10 meters wide. Pipe bundles are dumped into the gap and then used by the assaulting force to cross the obstacle. The fascine bundles include varying numbers of pipes, depending on the depth of the obstacle.

D-7 Tractor Protective Kit (TPK): The TPK is an easily installed, bolt-on, armor kit that provides the D-7 tractor and its operator with protection from small arms fire and from explosion fragments.

System Data

Anti-Personnel Obstacle Breaching System (APOBS)

Manufacturer: US Navy Laboratories (Panama City and Indian Head Island)
Weight: 120 pounds
Number deployed to SWA: 36

M58 Single Shot Line Charge/Mine Clearing Line Charge (MICLIC)

Prime Contractor: Morton Thiokol
Number deployed to SWA: More than 300

Mk 154 Triple Shot Line Charge

Prime Contractor: General Motors of Canada
Number deployed to SWA: 62

Track-Width Mine Roller (TWMR)

Prime Contractor: Urdan and Minowitz
Number deployed to SWA: At least 58 units

Full-Width Mine Rake (FWMR)

Manufacturer: US Army Belvoir Research, Development and Engineering Center (BRDEC) and Letterkenny Army Depot
Weight: Approximately 3500 lbs
Dimensions: 180.5" wide, 92.3" long, and 42" high
Number deployed to SWA: 59

Armored Combat Earthmover (M-9 ACE)

Prime Contractor: Boeing McGlaughlin York (BMY)
Crew: One
Gross weight: 54,000 lbs
Engine: Cummins Diesel (295 hp at 2,600 rpm)
Bridge Classification: 17 tons
Maximum speed: 30 mph
Ascending grade: 60 percent
Gradability: 20 percent
Trench width: 62 inches
Number deployed to SWA: 151

M728 Combat Engineer Vehicle (CEV)

Prime Contractor: General Dynamics
Military Load Classification: 60
Number deployed to SWA: Exceeding 55

Armored Vehicle Launched Bridge (AVLB)

Prime Contractor: Chrysler Corp. and Allison Steel
Military Load Classification: 60
Number deployed to SWA: Exceeding 110

Pipe Fascine

Prime Contractor: TD Molding
Military Load Class: 70 tons
Dimensions: 181 inches long, 186.6 inches wide
Weight: 5,513 pounds
Number deployed to SWA: 78 bundles

D-7 Tractor Protective Kit (TPK)

Manufacturer: Marine Corps Logistics Base, Albany, GA
Weight: 9,000 lbs
Level of protection: 14.4-mm all purpose rounds at 200 meters
Number deployed to SWA: 26

Employment

Many different systems were used in SWA to breach minefields and obstacles. During Operation Desert Storm, the Marine Corps fired 49 single shot and 55 triple shot line charges. The US Army used their MICLICs in a limited manner, and

depended on the FWMR mounted on a CEV when breaching suspected minefields. Due to the difficulty of transporting the TWMR using heavy semitrailers, the US Army did not use TWMRs.

The ACE proved very effective for breaching earthen berms, filling tank ditches, and cutting through wire fences. It also was used to make protective defilade positions for vehicles and weapon systems. The M9 ACE was used by the Marine Corps to breach fences, small berms, and potential minefields when other MCM equipment was unavailable.

To cross ditches and other gaps, facines were used by the US Marine Corps and AVLBs by the US Army. On occasion, bunkers and other strong points were eliminated using the demolition gun on the CEV.

After minefields were cleared, non-standard marking systems had to be fabricated since no effective method was available. Individual units used flags, colored barrels, panels, and other methods.

Performance

APOBS achieved minimal success. Some charges only partially detonated and combat engineers used others improperly. This performance can be attributed partly to operator unfamiliarity with the ordnance.

Some explosive charge detonation problems were encountered with the M58/MICLIC single shot line charge. Operators experienced difficulty in correctly orienting the trailer on which the line charge was mounted. The vehicle towing the line charge could not back out of a plowed lane with the trailer in tow. It was difficult to tow the line charge from the staging area to the obstacle area and keep the system operational. The Mk 154 triple shot line charge performed better than the M58/MICLIC, but only 49 percent were successfully deployed and command detonated as designed.

Because of the soft soil conditions in the desert, the FWMR was an effective tool, creating easily visible lanes for follow-on forces. The FWMR was one of only two systems available for assaulting forces when encountering blast-hardened mines.

Generally, the TWMR was unsuccessful in breaching operations. Specifically, it failed to breach several minefields consisting of continuous pressure mines. It was slow, cumbersome, and bogged down in soft sand. The US Army did not use the TWMR for breaching.

The M9 ACE was a versatile system. The soft desert soil caused some traction problems, which limited its speed to about 20 mph. Overall, the ACE quickly and effectively performed its missions.

TPKs performed as intended and at least one D-7 operator was protected from the explosion of a land mine.

Each use of pipe fascine required four bundles from two AAVs to breach adequately ditches that were usually three to four meters wide and two to three meters deep. The AAVs laying the pipes often were exposed to flanking anti-tank and /or anti-armor fire during employment. An excavation vehicle was required to reduce the escarpment after the breach was completed using the pipe fascines.

The CEV and AVLB performed their roles effectively when they were able to keep pace with maneuver forces. Mounting the FWMR on the CEV provided the only full-width breaching capability for the US Army.

OBSERVATIONS

Accomplishments

- The Mk 154 successfully cleared breach points for vehicle passage.
- The FWMR was developed and fielded in under four months, and was very effective in clearing lanes, leaving a visible path through minefields after line charges cleared wire obstacles and marked a path.
- The M9 ACE was successful in myriad tasks, including obstacle reduction.

Shortcomings

- The M58/MICLIC single shot line charge and associated trailer were not as rugged as required. There also was no means of ensuring correct orientation of the charge from inside an enclosed vehicle.
- Line charges, both the single shot and triple shot were ineffective against the modern, blast-hardened land mines encountered in SWA.
- Minefield breaching forces did not have adequate standard systems to mark lanes through minefields once they were breached and verified cleared.
- The TWMR bogged down too easily in softer soils, was cumbersome to transport to the obstacle area, and generally did not provide high confidence that a lane was actually clear of mines.
- No system was available for rapid self-breaching of scatterable mines, if they had been encountered away from a deliberate breach site.
- No real-time standoff minefield detection capability existed.
- The pipe fascine was successfully used in obstacle and ditch crossings; however, the vehicle carrying the bundles was extremely vulnerable to enemy fire when deploying the bundles. This breaching method is recommended as an expedient only.

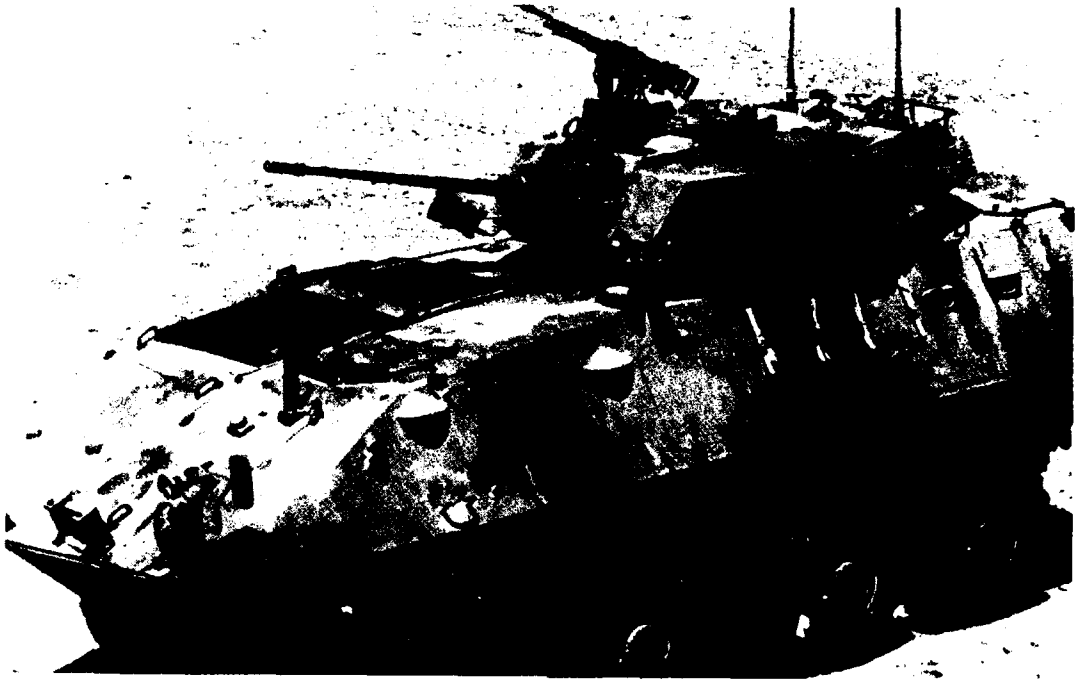
Issues

- There is a need for dedicated counterobstacle vehicles, as mobile and survivable as the maneuver forces, designed specifically to counter the land mine threat.

- There is a need for a self-breaching capability for all units in the forward combat areas, designed to counter scatterable mines.

- There is a need for a strong RDT&E program to advance standoff mine detection, neutralization and marking capability.

LIGHT ARMORED VEHICLE (LAV)



LAV-25

Mission

The Light Armored Vehicle (LAV) is operated by a Marine Corps (USMC) Light Armored Infantry (LAI) battalion, which conducts reconnaissance; security and economy of force operations; and, within its capabilities, limited offensive and defensive operations. The LAV consists of six variants. The nucleus of the battalion is the LAV-25 Scout/Reconnaissance vehicle. The remaining variants exist in smaller numbers to complement and support the LAV-25.

System Data

Prime Contractor: Diesel Division, General Motors of Canada
Initial Operational Capability: 1985
US Inventory: 724
Propulsion: 275 hp diesel engine
Maximum speed: 62 mph (land), 6 mph (water)
Maximum range: 410 miles
Maximum trench: 81 inches
Maximum grade: 60 percent head on
Maximum side slope: 30 percent angle

LAV-25

Crew: Seven (commander, driver, gunner, and four scouts)
Combat weight: 28,200 lbs.
Armament: M242 25-mm chain gun (fires high explosive and armor-piercing ammunition), M240 7.62-mm machine gun (coaxially mounted with chain gun), M240 7.62-mm machine gun (pintle mount).

LAV ANTITANK (LAV-AT)

Crew: Four (commander, gunner, loader, and driver)
Combat weight: 27,650 lbs.
Armament: TOW missile system, M240 7.62-mm machine gun (ring mount)

LAV MORTAR (LAV-M)

Crew: Five (commander, driver, and three mortar men)
Combat weight: 26,700 lbs.
Armament: M252 81-mm mortar, M240 7.62-mm machine gun (ring mount)

LAV LOGISTICS (LAV-L)

Crew: Three (commander, driver, cargo handler)
Combat weight: 28,200 lbs.
Payload: 5,240 lbs.
Armament: M250 7.62-mm machine gun (ring mount)

LAV COMMAND AND CONTROL (LAV-C2)

Crew: Seven (commander, driver plus five radio operator/staff members)
Combat weight: 27,060 lbs
Radios: Four VHF, one UHF, one HF
Armament: M240 7.62-mm machine gun (ring mount)

LAV RECOVERY (LAV-R)

Crew: Three (commander, driver, and boom operator)
Combat weight: 28,320 lbs.
Armament: M240 7.62-mm machine gun (ring mount)

Employment

More than 350 LAVs of all types were used in SWA, (193 LAV-25, 54 LAV-AT, 26 LAV-M, 30 LAV-C2, 47 LAV-L, 22 LAV-R). LAI units were in frequent and sometimes sustained contact with Iraqi forces before and during the ground campaign. LAI units provided a protective screen for the Marine divisions. LAI units scouted Iraqi minefields and the breach points which eventually were used on G-Day. Additionally, they performed economy of force missions and feints, which successfully deceived the enemy as to friendly intentions.

Performance

Land-based LAVs proved flexible, responsive and adaptable. They experienced no special maintenance reliability problems as a result of the desert environment. Operational readiness (OR) throughout Operation Desert Shield ranged from 88 to 98.5 percent, with 95 percent being typical. Highest readiness rates were achieved just before G-Day. During the Offensive Ground Campaign, readiness exceeded 94 percent. This readiness was achieved through an intense maintenance effort and extensive use of parts obtained through selective interchange with other LAVs in theater.

Afloat LAVs experienced a lower OR rate (as low as 76 percent at one point, with 93 percent the average). Although vehicles operated ashore were at higher risk for breakage, component failures can happen when the vehicle sits idle aboard a ship. Crewmen performing preventive maintenance aboard ship will discover systems and parts that fail. The lower OR rate for vehicles afloat reflects the inability to use parts sources available to units ashore.

The LAV-25 does not have a thermal imaging capability. Its passive night sight is marginally effective, requires significant ambient illumination, and provides no capability on an obscured battlefield (night or day). Without thermal imaging, the LAI battalion experienced severe operational restrictions low visibility conditions.

The Global Positioning System (GPS) received praise from all users. It was provided on a temporary basis and in insufficient numbers to equip each vehicle. Because of the extended dispersion and frontages at which LAI companies and platoons operate, users felt strongly that each LAV-25 and LAV-AT should have GPS.

OBSERVATIONS

Accomplishments

- Deployed rapidly in operationally significant numbers.
- Demonstrated high maintenance reliability.
- Proved to be flexible, adaptable, and responsive.
- Provided protective screen for USMC forces.
- Provided effective reconnaissance.

Shortcomings

- Because of a lack of thermal sights, LAVs had reduced effectiveness at night and on the obscured battlefield.

Issue

- A thermal imaging system for the LAV-25 is an initiative for FY 94.

M1A1 ABRAMS TANK

Mission

The M1A1 Abrams tank is a full-tracked, armored combat vehicle capable of sustained offensive and defensive combat in a nuclear, biological, and chemical (NBC) environment. It used by both the US Army and the US Marine Corps (USMC), and is designed to close with and destroy enemy forces using shock action, firepower, and mobility in coordination with supporting ground and air forces in all battlefield conditions.

There are three variants:

M1 - The M1 tank is the initial model, which was introduced in 1981. It has a 105-mm gun along with enhanced survivability and improved fire control.

M1A1 - The M1A1 is the basic A1 model. The major improvements from the basic M1 model include a 120-mm main gun, NBC overpressure system, and armor packages.

M1A1 Heavy Armor (HA) - The M1A1 Heavy Armor model is the same as the A1 model except that some specific armor packages (made from depleted uranium) are added.

System Data

Prime Contractor: General Dynamics
Crew: Four
Initial Operational Capability: FY 1985 (M1A1); FY 1987 (M1A1HA)
US inventory: 2,445 (M1A1); 1,753 (M1A1HA)
Combat weight: 67.5 tons (loaded with enhanced armor and T158 track)
Engine: 1,500 hp, air-cooled turbine
Cross country speed: 30 miles per hour
Weapons:
Main armament: M256 120-mm smooth bore cannon
Coaxial weapon: M240 7.62-mm machine gun
Loader's weapon: M240 7.62-mm machine gun
Commander's weapon: M2 .50 caliber machine gun
Main gun basic load: 40 rounds
Fuel capacity: 498 gallons of DF-2, DF-1, DFA, or JP-8
Operational range: 127 miles (NBC protection on), 130 miles (NBC protection off)
Cruising range: 279 miles (NBC protection on), 289 miles (NBC protection off) at 29 mph on dry, level roads

Employment

During Operation Desert Storm, the Army used 1,178 M1A1 and 594 M1A1(HA) tanks (approximately 2,300 M1A1 series tanks were deployed, but 528 tanks were placed in operationally ready float status and theater war reserve stock). These tanks were used in Operation Desert Storm to provide anti-armor lethality and high-speed maneuver in the Coalition's heavy forces. The M1A1 tank was the spearhead during the ground campaign. The USMC deployed 16 M1A1 and 60 M1A1(HA) tanks in Operation Desert Storm. These tanks were fielded quickly to

counter the Iraqi armored threat and then used to exploit obstacle belt penetrations during the ground offensive.

Because of the threat posed by Iraqi T72M-1 tanks and chemical weapons, efforts were made to place the latest M1A1 and M1A1(HA) tanks into Army units. M1A1s from stocks in Europe and M1A1(HA)s from production facilities were shipped to Saudi Arabia and an all-out effort was conducted between November and 15 January to modernize the armor fleet. These tanks provided crews with better survivability because of the special armor packages and NBC overpressure system.

Performance

After-action reports from divisions and brigades indicate readiness rates greater than 90 percent, based on vehicles able to "shoot, move, and communicate." These statistics were achieved by units moving between 200 and 370 kilometers in 100 hours of high-speed offensive maneuver (e.g., the 3d Armored Division moved more than 300 tanks at night across 200 kilometers without any breakdowns). Several factors contributed to this success. First, many new, low-mileage systems were used. Second, parts from reserve tanks in the United States and Europe and excess tanks in the theater of operations were used to bring some tanks to full operational status. Third, Heavy Equipment Transporters (HET) were used to move tanks forward in theater as much as possible. Although the HET shortage was a problem, movement of tanks by HETs greatly reduced wear. Finally, extensive preventive maintenance kept tanks in running order. Reductions in thrown tracks by ensuring proper track tension was applied and the reduction of engine wear and replacement by seal inspections and proper, frequent cleaning of filters were major contributors to the high operational readiness rate.

The capability of the M1A1 tank's equipment, coupled with crew skill and training, enabled M1A1 crews to "see first, shoot first," resulting in many one-round kills on armored vehicles. Thermal Imaging Systems allowed detection of Iraqi targets day and night in smoke and haze at great distance. Iraqi systems lacked this capability. Targets were routinely identified out to 1,500 meters and detected at much greater ranges with the median detection range of 2,600 meters. M1A1 crews were able to engage Iraqi tanks well beyond the range of Iraqi T-72s and reports from enemy prisoners of war indicate they could only return fire at muzzle flashes. An Armor School report stated, "120-mm ammunition consistently achieved catastrophic kills against T-72 tanks, even when [the T-72s were] behind thick berms." An example of the agility, mobility, and lethality of the M1A1 tank was demonstrated by the 2nd Brigade, 1st Armored Division at the Battle of Medina Ridge. In a 45-minute battle, the unit achieved tactical surprise by moving quickly and silently and destroyed 100 Iraqi tanks and more than 30 BMPs. Finally, interviews with crews indicate many engagements occurred "on the move" (15 to 25

km/hr), and involved engagements at all angles. The M1A1 frequently outran other US systems on the battlefield.

The low loss rate points to the survivability of the M1A1 tank. Vehicle speed and agility, identification and early engagement of the enemy at long range, thermal capabilities, armor protection, training, and crew survivability measures all contributed to M1A1 survivability. Several sources reported impacts of 125-mm armor-piercing ammunition on M1A1s without a single penetration, but these reports have not been corroborated. Of the 18 combat damage incidents reported, nine were permanent losses caused by fire from friendly forces. The damage inflicted on the other nine M1A1s were mostly from mines and are considered repairable.

OBSERVATIONS

Accomplishments

- The M1A1 series tanks were used successfully in fast-paced, complex offensive and defensive operations in all environments; they demonstrated all weather and night capability through sandstorms, rain, and haze from oil field fires with little degradation.
- M1A1 systems overmatched Iraqi systems in acquisition, fire control, lethality, mobility, and survivability.
- Operational readiness rates were more than 90 percent throughout the campaign.
- Many first round hits occurred while the vehicle was on the move.
- M1A1 ammunition produced catastrophic kills against Iraqi armor.

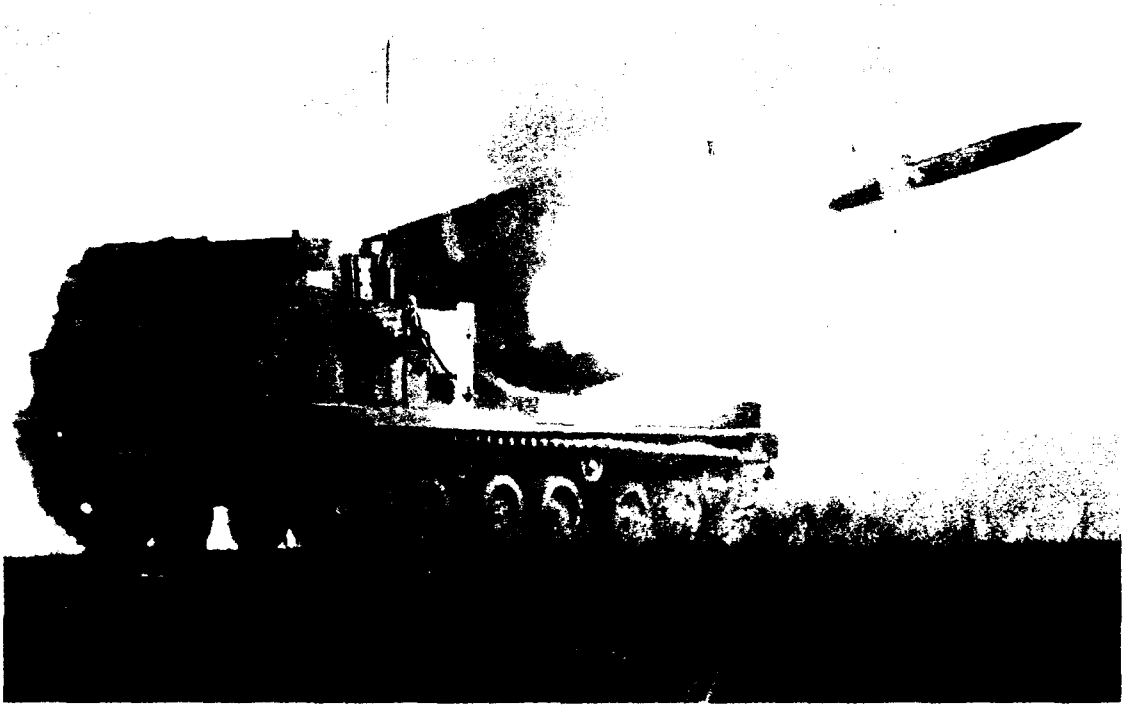
Shortcomings

- The M1A1 lacked a positive combat vehicle identification system, such as higher resolution thermal sights which would improve detection, recognition, and identification.
- The M1A1 did not have an onboard vehicle navigation device.
- M1A1 fuel consumption was high.
- Other combat support and combat service support systems are not as mobile as the M1A1 and this restrains the overall maneuver speed.

Issues

- Shortcomings identified during Operation Desert Storm are being corrected. A commanders' independent thermal viewer and an onboard position/navigation device will be organic equipment on the new M1A2 tank.
- Programs have begun to improve combat vehicle identification and prevent fratricide incidents. The Army is looking at second generation forward looking infrared to improve recognition and identification for TIS.

MULTIPLE LAUNCH ROCKET SYSTEM (MLRS) AND ARMY TACTICAL MISSILE SYSTEM (ATACMS)



MLRS

Mission

The multiple launch rocket system (MLRS) is a long-range free-flight rocket system that provides general support artillery fires to division and corps level tactical units. At the division level, MLRS is organized into a nine-launcher battery. At the corps level, MLRS units consist of one or more battalions of 27 launchers.

In addition to the command and control, fire direction and logistic support elements common to all field artillery units, the MLRS consists of self-propelled loader launcher (SPLL) and a family of MLRS munitions. During Operations Desert Shield and Desert Storm, two different types of MLRS munitions were used: the Army Tactical Missile System (ATACMS) and the M77 rocket. The M77 rocket is packaged in six-round pods. When fully loaded with two pods, the SPLL can fire 12 rockets in less than one minute. The rocket consists of a solid rocket motor and a warhead containing 644 dual purpose grenades for use against personnel and lightly armored targets. An area coverage weapon system, one MLRS M77 rocket can dispense its grenades across four to five acres. If a launcher were to fire its full load of 12 rockets, the target area coverage would exceed 30 acres.

ATACMS, a multi-purpose system, is a ballistic missile fired from the M270 MLRS launcher. ATACMS replaced the conventional Lance missile system and is used to attack soft, stationary, semi-fixed targets (e.g., surface-to-surface missile sites, air defense sites, logistics sites, and command, control, communications, and intelligence facilities). ATACMS is the operational commanders' deep strike weapon system.

System Data

MLRS

Prime Contractor: LTV Aerospace and Defense Co.
Crew: Three (driver, gunner and section chief)
Initial Operational Capability: 1983 (MLRS); 1990 (ATACMS)

M270 Launcher (lightly armored, self-propelled, tracked vehicle, variant of Bradley armored fighting vehicle chassis)

Weight: 25 tons
Propulsion: 500 hp diesel engine
Maximum. speed: 40 mph
Cruising range: 298 miles

M77 Rocket

Length: 155 inches
Weight: 675 lbs
Range: 32 km
Guidance: unguided
Warhead: 644 M77 antipersonnel and antimaterial grenades

ATACMS

Length: 13 feet
Propulsion: Solid propellant rocket motor
Guidance System: Inertial navigation

Employment

During Operation Desert Shield, 189 MLRS SPLLs were deployed to the theater. MLRS fired 9,660 rockets in combat at targets such as artillery, convoys, logistics sites, and troop positions. First operational in August 1990, ATACMS production was accelerated soon after the crisis began. Two deep attack capable MLRS batteries (18 SPLLs), specially configured with deep battle kits to fire ATACMS, were deployed to Saudi Arabia. A conversion team with nine deep battle kits also deployed to Saudi Arabia to convert standard MLRS to ATACMS capable batteries. ATACMS was used against a variety of targets including surface-to-air missile sites, rocket and artillery batteries, logistics and refueling sites, and convoys.

Performance

In combat for the first time, MLRS performed well. MLRS rocket fires had a tremendous psychological impact on Iraqi soldiers. Enemy soldiers were terrified of its destructive force, which they sometimes referred to as "steel rain." The MLRS rockets proved to be extremely effective against personnel and unarmored vehicles. In addition to its lethality, two other attributes exemplified this system's performance: long range capability and the ability to keep pace with the fast moving M1A1 tank and M2/3 armored fighting vehicles. However, US rocket systems were out-ranged by the Iraqi Astros II multiple rocket launcher (60 km). Accurate targeting of Iraqi positions by ground and air units overcame this disadvantage.

ATACMS apparently silenced targeted air defense sites; electronic emissions ceased soon after sites were attacked by ATACMS. Coalition aircraft flying through flight corridors cleared by ATACMS strikes reported no enemy air defense radar activities. Based on demonstrated performance during suppression of enemy air defense missions, Army Component, Central Command requested all available ATACMS assets for use in the ground offensive.

ATACMS was a highly responsive system. A-10 pilots requested a short notice ATACMS strike on an air defense site and ATACMS responded within minutes, completely destroying the target. During one ATACMS strike, more than 200 unarmored vehicles were destroyed as they attempted to cross a bridge.

OBSERVATIONS

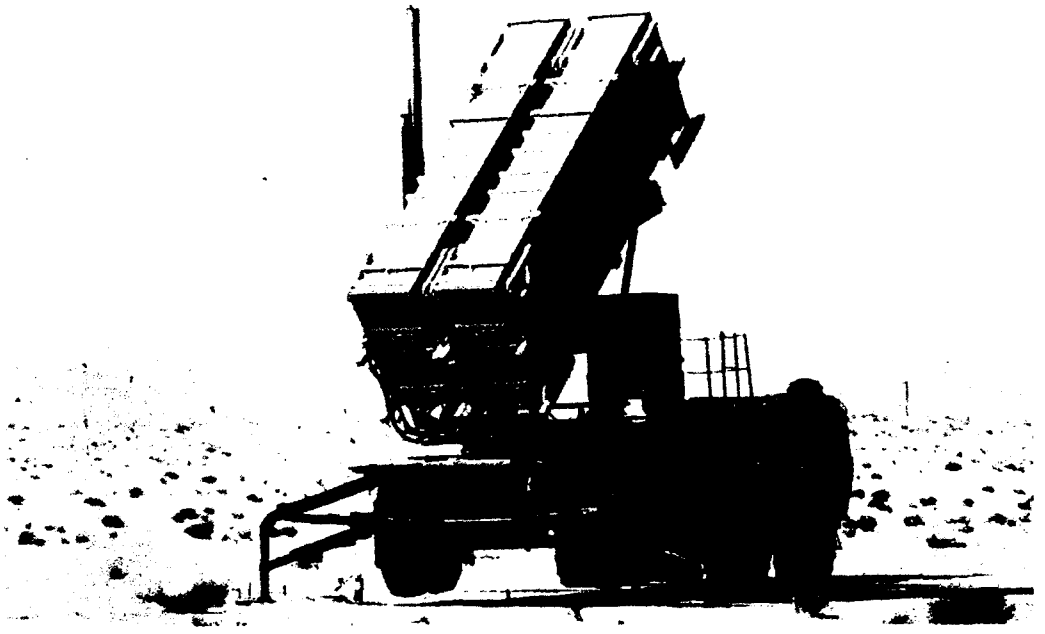
Accomplishments

- MLRS was lethal and extremely effective at long ranges against a variety of targets.
- MLRS was responsive and delivered large volumes of accurate fires in day or night and during all types of weather, especially intense rain and dust storms.
- MLRS was very maneuverable and was the only field artillery system that kept up with fast-paced maneuver advances.
- ATACMS accuracy met or exceeded operational requirements, and ATACMS destroyed or silenced most targets attacked.

Shortcomings

- Ground commanders desired an ATACMS and rocket system with even greater range.
- The M77 rocket was not effective against moving armored targets like tanks.

PATRIOT AIR DEFENSE SYSTEM



Mission

The Patriot Air Defense System provides medium-to-high altitude air defense of ground forces and crucial assets against air breathing threats (ABTs) and tactical ballistic missiles (TBM).

System Data

Prime Contractor: Raytheon
Patriot battery (fire unit): One radar, one engagement control station, one to eight launchers with four missiles on each launcher, and one electrical power plant
Crew: Launcher crew – three; van crew – three
(up to eight launchers per van in a fire unit)
Initial Operational Capability: 1982
Guidance: Command guidance and semi-active homing

A Patriot battery includes up to eight launchers, each with four MIM-104 missiles, and support equipment, including a multi-function phased-array radar, weapons control computer, electric power plant, and equipment to interface with other parts of the air defense system and higher headquarters. Missiles with Patriot anti-tactical missile capability (PAC-2) enhancements (warhead and fuze improvements in addition to PAC-1 software improvements) are capable of anti-tactical ballistic missile (ATBM) defense as well as defense against ABTs. PAC-1 missiles are used only for defense against ABTs.

Employment

Patriot units normally are deployed as directed by the battalion commander based on the area to be defended and the expected axis of attack. The configuration provides coverage against both air-breathing and TBM threats. Patriot units are positioned in overlapping or independent configurations, depending upon weapons available and the number and location of assets to be protected. Overlapping coverage is preferred because of the redundancy it offers during attacks as well as the fact it offers more continuous coverage while individual fire units stand down for periodic maintenance, and movement.

Twenty-one US batteries (132 launchers) deployed to Saudi Arabia. Four batteries (two US and two Dutch batteries for a total of 26 launchers) deployed to Turkey. None of the four batteries in Turkey was involved in any engagements. Seven Patriot batteries (four US, one Dutch, and two Israel Defense Force (IDF) batteries for a total of of 48 launchers) were used in Israel. The two IDF batteries received abbreviated training in the United States, and the crews were supplemented by US maintenance personnel. The Dutch battery did not deploy to Israel until several days before the end of the war and was not involved in any Scud engagements. Patriot batteries in Saudi Arabia were used primarily to protect crucial assets (e.g., airfields, ports,oil production and refinery facilities, logistics bases, command and control centers, and Corps maneuver elements). In Israel, Patriot provided limited area defense for selected population centers. In Turkey, Patriot batteries were positioned to defend Turkish air bases.

Performance

The Patriot system does not have embedded digital data collection, which prevented a detailed and quantitative analysis of each firing. Therefore, a complete quantitative analysis of Patriot effectiveness is not available. The Army developed preliminary quantitative results based upon the best operational data then available. Action continues to obtain and analyze additional data from diverse sources and agencies. Even with the results of this continuing analysis, a finite, quantitative scoring of Patriot effectiveness may not be possible.

The system's operational success during the Gulf War can, however, be measured qualitatively. Patriot batteries provided valuable protection of Saudi ports and airfields, and served as a confidence-building asset to Coalition forces and civilians. The system played an important role in keeping Israel out of the war and strengthening Coalition resolve. The Patriot system was designed to defend small areas, like Saudi Arabian airfields. During the war, however, Patriot was also used to protect large cities, such as those in Israel. Consequently, Scud damage generally was greater in Israel, where the areas surrounding defended assets were more densely developed, than in Saudi Arabia, where defended assets often were more isolated.

Patriot had a mission capable rate of 95 percent in SWA.

OBSERVATIONS

Accomplishments

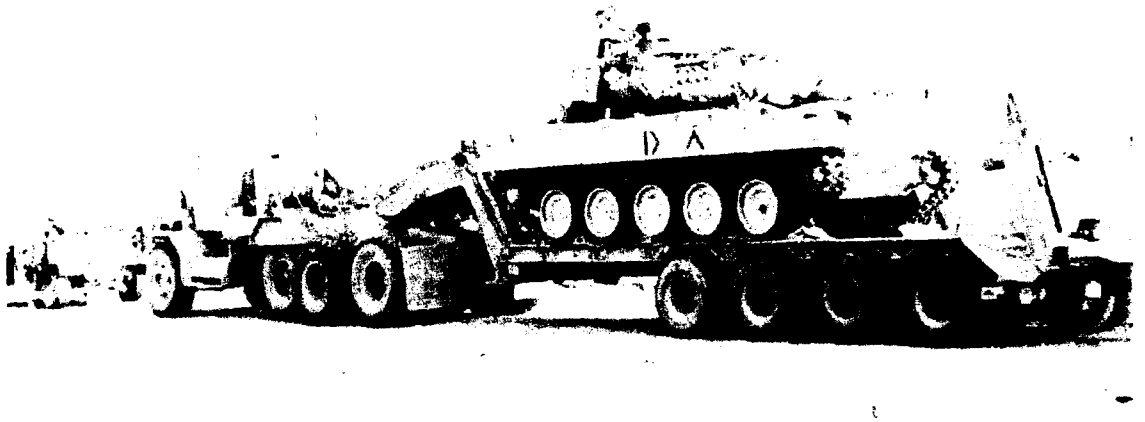
- A system designed to shoot down aircraft was modified to provide a successful ATBM system.

- Patriot was successful politically – it helped keep Israel out of the war and strengthened Coalition resolve.

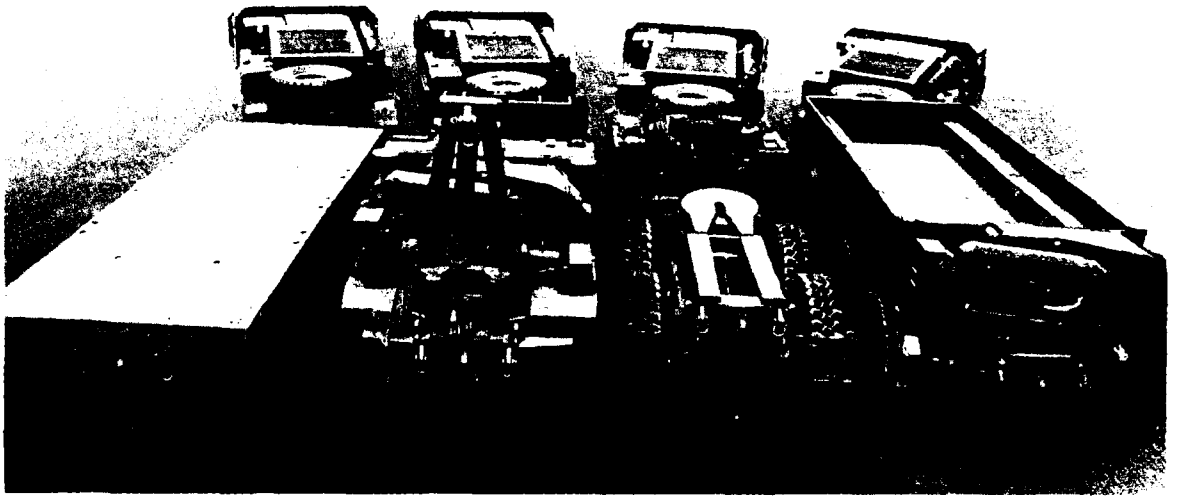
Issue

- Shortcomings have been identified and continue to be addressed through software changes and funding for improvements. Two major software changes were made during Operation Desert Storm that greatly improved Patriot's capability to identify and destroy the Scud warhead. Funding has been appropriated for near- and mid-term upgrades, which will let Patriot engage TBMs at a higher altitude and greater range.

TACTICAL WHEELED VEHICLES (HEAVY FLEET)



US Army Heavy Equipment Transporter (HET)



USMC Logistic Vehicle System (LVS)

Mission

The Army's heavy fleet of tactical wheeled vehicles consists of old and new vehicles, as well as a mix of both commercial and tactical models. The missions performed were contingent on the type of vehicle, tactical or commercial. The heavy expanded mobility tactical truck (HEMTT) provides fuel and ammunition to combat units. The tractor version pulls heavy systems such as the Patriot missile system. The wrecker version performs recovery roles. The HEMTT is an 8X8 diesel powered 10-ton truck. The heavy equipment transporter (HET) mission is to transport tanks and other heavy equipment. The tractor is an M911 with an 8X6 diesel engine with pusher axle. The companion trailer is the M747 rated at 60 tons. The line haul tractor (LHT) (M915 and M915A1) pull M872 series 34-ton semitrailers. The M915 series is a 6X4 diesel powered vehicle. It is a commercial-type vehicle designed for highway use. The engineer tractors are M916 light equipment transporters and the M920 medium equipment transporter. The mission of these vehicles is to transport engineer equipment such as bulldozers. The M916 is a diesel-powered 6X6. The M920 is a diesel-powered 8X6.

The Marine Corps's (USMC) Logistic Vehicle System (LVS) is composed of two separate chassis units coupled together through an articulation joint to form an 8X8, diesel-powered vehicle. The front power unit, Mk 48, when coupled with the five rear body units, (Mk 14 container hauler; Mk 15 wrecker recovery vehicle; Mk 16 fifth wheel; Mk 17 dropside cargo hauler with crane; and the Mk 18 ribbon bridge transporter/self loading container hauler) transports bulk and containerized liquid and dry cargo. Four primary combinations, (Mk 48/Mk 14, Mk 48/Mk 15, Mk 48/Mk 16, and Mk 48/Mk 17) were used during Operations Desert Shield and Desert Storm. The Mk 18 was undergoing its initial production test and was not deployed.

System Data (US Army Heavy Fleet)

Heavy Expanded Mobility Tactical Truck (M977)

Prime Contractor: Oshkosh Truck Corporation
Crew: Two
Initial Operational Capability: 1985
US Inventory: 11,177
Curb weight: 35,500 pounds
Payload: 24,500 pounds
Length: 401 inches
Width: 96 inches
Height: 112 inches
Propulsion: 445 hp diesel engine
Trailer towing capacity: 40,000 pounds
Range: 300 miles

Heavy Equipment Transporter (M911/M747)

Prime Contractor: Oshkosh Truck Corporation
Crew: Two
Initial Operational Capability: 1978
US Inventory: 750
Curb weight: 39,952 pounds
Payload: 106,000 pounds
Length: 369 inches
Width: 114 inches
Height: 144 inches
Propulsion: 435 hp diesel engine
Trailer towing capacity: N/A
Range: 420 miles

Line Haul Tractor (M915)

Prime Contractor: Freightliner
Crew: Two
Initial Operational Capability: 1979
US Inventory: 4,667
Curb weight: 19,720 pounds
Payload: 54,000 pounds
Length: 262 inches
Width: 96 inches
Height: 142 inches
Propulsion: 400 hp diesel engine
Trailer towing capacity: N/A
Range: 357 miles

Light Equipment Transporter (M916)

Prime Contractor: Freightliner
Crew: Two
Initial Operational Capability: 1980
US Inventory: 1,759
Curb weight: 24,971 pounds
Payload: 50,000 pounds
Length: 294 inches
Width: 96 inches
Height: 142 inches
Trailer towing capacity: N/A
Range: 357 miles

Medium Equipment Transporter (M920)

Prime Contractor: AM General (Not in production)
Crew: Two
Initial Operational Capability: 1980
US Inventory: 992
Curb weight: 30,270 pounds
Payload: 55,000 pounds
Length: 319 inches
Width: 96 inches
Height: 142 inches
Trailer towing capacity: N/A
Range: 357 miles

System Data (USMC Logistic Vehicle System)

US Inventory: 1,655
Initial Operational Capability: 1985
Propulsion: 445 hp diesel engine

Mk 48/Mk 14 Container Hauler

Prime Contractor: Oshkosh Truck Corp
Crew: Two
Curb Weight: 40,200 pounds
Payload: 25,000 pounds cross-country, 45,000 pounds highway
Length: 456 inches
Width: 96 inches
Towed Load: 60,000 pounds
Range: 300 miles

Mk 48/Mk 15 Wrecker Recovery Vehicle

Prime Contractor: Oshkosh Truck Corporation
Crew: Two
Curb Weight: 52,300 pounds
Payload: 20,000 pounds cross-country; 45,000 pounds highway
Length: 444 inches
Width: 96 inches
Towed Load: 60,000 pounds
Range: 300 miles

MK48/Mk 16 Fifth Wheel Semitrailer Adapter

Prime Contractor: Oshkosh Truck Corporation
Crew: Two
Curb Weight: 40,500 pounds
Payload: 188,000 pounds (gross combination weight rating)
Length: 397 inches
Width: 96 inches
Towed Load: M870 and M-1000 Semitrailers
Range: 300 miles

MK48/Mk 17 Dropside Cargo With Crane

Prime Contractor: Oshkosh Truck Corporation
Crew: Two
Curb Weight: 47,800 pounds
Payload: 20,000 pounds cross-country; 40,000 pounds highway
Length: 456 inches
Width: 96 inches
Towed Load: 60,000 pounds
Range: 300 miles

Employment

The HEMTT provided fuel and ammunition to armor, artillery, and infantry units. To support the theater campaign plan, 1,343 HEMTTs were sent in excess of normal unit allowances. The purpose of these vehicles was to augment or replace 5,000 gallon tankers and 22½-ton semitrailers in divisions and Armored Cavalry Regiments. The HEMTT tanker has a capacity of 2,500 gallons. Therefore, 5,000 gallon tankers were replaced on a two-for-one basis. The cargo HEMTTs augmented the semi-trailers in the forward areas or replaced them on a one-for-one basis. Of the 11,177 HEMTTs in the Army's inventory, 4,410 were deployed.

The LHT was used in the line haul mode as in any commercial tractor or trailer operation. Its primary limitation was little or no off-road capability. Of the 4,667 M915 in the Army's inventory, 2,337 were deployed. The HETs were used to move tanks and other equipment to the forward areas. This was a change in doctrine for the Army. Previously, the HET mission had been to remove damaged equipment from collection points to repair facilities and to bring new equipment to units. A secondary mission was unit transportation. Executing the theater campaign plan required moving many tracked vehicles across great distances by truck. Using HETs for this purpose saved wear and tear on the equipment, so the tracked vehicles were ready for battle when needed. Initially, the Army did not have enough assets to meet this requirement. A worldwide search was conducted and 1,404 HETs were found to meet the 1,295 requirement. The HETs were provided from Egypt, Italy,

Germany, Saudi Arabia, US leased and US off-the-shelf procurements. The employment doctrine developed for Operation Desert Storm has become the Army's new doctrine for heavy HET employment. Of the 750 HETs in the inventory, 497 were deployed. The engineer tractors transported engineer equipment. Of the 1,759 M916, 468 were deployed. Of the 992 M920, 152 were deployed.

The USMC's LVS was developed to provide a common, multipurpose, heavy-lift vehicle sized for both expeditionary and division level transportation requirements. The bulk of I Marine Expeditionary Force supplies and equipment were moved from port to the forward operating areas by the LVS. Of the 1,655 LVSs in the USMC inventory, 615 were deployed.

Performance

The HEMTT's operational readiness rate of greater than 90 percent exceeded Army standards. It operated superbly in terrain that had become a quagmire because of rain. The HEMTT kept up with the tracked vehicles. One commander substituted HEMTTs for tracked ammunition carriers because of their greater reliability and mobility. LHT (M915) performed their line haul mission well and were able to move large quantities of supplies. Their lack of mobility limited their use mainly to improved roads. If it went off-road, the surface had to be hard or the vehicle had to be assisted by a HEMTT. The military HET was overloaded when carrying the M1A1 tank. The new HET, capable of transporting the M1A1 tank with the tank crew in its cab, was not available. The HET maintained an operational readiness rate approaching 90 percent.

One vehicle the Army did not deploy was the Palletized Load System (PLS). The British and French Armies deployed this system. PLS vehicles were used to transport fuel, water, ammunition, containers and Multiple Launch Rocket System rocket pods. Both the UK and France were pleased with the performance of the PLS system. US commanders indicated during interviews that the US PLS would have enabled the logistics system to operate more effectively.

The LVS was a highly mobile, extremely flexible, heavy-wheeled vehicle. The tandem-tow (two Mk 14 trailers or Mk 17/Mk 14 combination) doubled each LVS' carrying capacity without an increase of crew. This combination could be operated well on both highway or rough terrain. The Mk 48/Mk 16 facilitated the movement of Material Handling Equipments (MHE) using M870 trailers. The Mk 48/Mk 17 rear body unit was able to offload itself and other vehicles thus providing relief for MHE. The Mk 48/Mk 15 was an excellent recovery asset for all vehicles. The LVS also was able to keep pace with forward mechanized units during offensive operations. The LVS readiness rating ranged from 92 percent to 95 percent throughout Operations Desert Shield and Desert Storm.

OBSERVATIONS

Accomplishments

- The HEMTT was praised for its performance by both commanders and soldiers.
- A new doctrine developed for HET employment.
- The reliability and mobility of the LVS was a significant factor in the accomplishment of the USMC's mission.

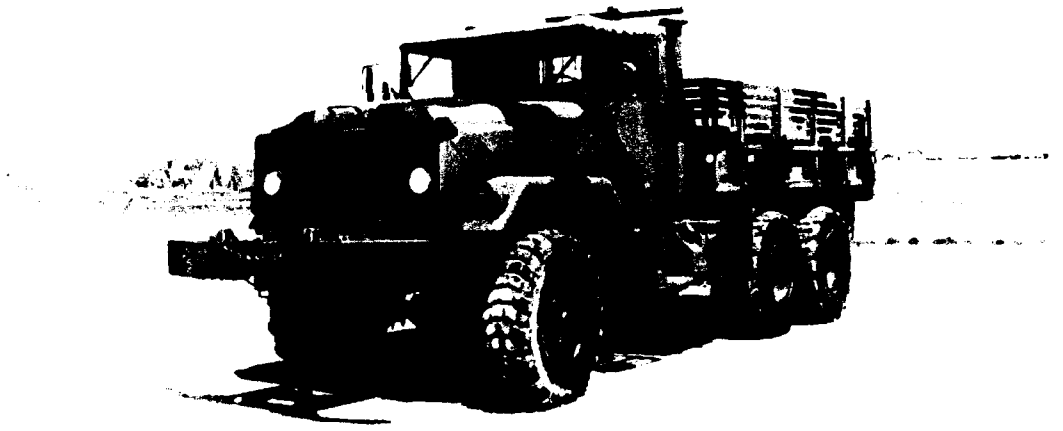
Shortcomings

- The M1A1 tank overloaded the HET.
- The HET lacks cross-country mobility.
- The LHT was not mobile off roadways.
- LHTs created problems for forward units because trailers could not be off-loaded and 40-ft containers were difficult to handle.

Issues

- PLS would have made logistics operations more efficient in Operations Desert Shield and Desert Storm. The British and French proved the system was effective, delivering all types of cargo and reducing truck requirements. The French were able to load flatracks for their system while the truck was in transit. The driver could drop his load at the destination without waiting for the cargo to be off-loaded.
- A new HET version will replace the current HET. It has a 70-ton capacity, super single radial tires, central tire inflation system and can transport the tank crew. HET unit structure has been increased from 36 to 96 trucks per company to meet the new doctrine requirement.

TACTICAL WHEELED VEHICLES (MEDIUM FLEET)



5-ton Truck

Mission

The medium fleet consists of both 2½- and 5-ton vehicles; the fleet deployed for Operations Desert Shield and Desert Storm consisted of both old and new vehicles. The 2½-ton truck performs unit missions such as unit supply vehicle, mess truck, communications systems carrier, maintenance van, water truck, fuel truck and troop transport. The 2½-ton truck fleet consisted of a mix of gas powered and multi-fueled vehicles. The 5-ton truck missions include general cargo and troop transport; tractor prime mover for 22½-ton cargo semitrailers and 5,000 gallon fuel tankers in Corps and Divisional units; fuel and ammunition transport; prime mover for the 155-mm towed howitzer, wrecker operations and repair van. In Operations Desert Shield and Desert Storm there were gas powered, diesels and multi-fuels.

System Data

2½-Ton Truck (M44 Series)

Prime Contractor: AM General Corporation
Crew: One driver
Initial Operational Capability: 1953
US Inventory: 68,700
Curb weight: 13,200 pounds
Payload: 5000 pounds
Length: 278 inches
Width: 93 inches
Height: 112 inches
Propulsion: Gasoline and multi-fuel 140 to 160 hp engines
Trailer towing capacity: 6,000 pounds
Range: 300 miles

5-Ton Truck (M39 Series, M809 Series, M939 Series, M939A1 Series, M939A2 Series)

Prime Contractor: BMY Wheeled Vehicles Division of Harsco Corporation
Crew: One driver (assistant with tractor)
Initial Operational Capability: 1989
US Inventory: 15,195
Curb weight: 22,175 pounds
Payload: 10,000 pounds
Length: 310 inches
Width: 98 inches
Height: 120 inches
Propulsion: 240 hp diesel engine.
Trailer towing capacity: 15,000 pounds
Range: 300 miles

Employment

The 2½-ton truck was used in its standard mission roles. Of the 67,700 2½-ton trucks in the Army's inventory, 14,000 were used Operations Desert Shield and Desert Storm. The 5-ton truck performed all of its missions. Particularly important was the movement of 5,000 gallon fuel semitrailers to the forward areas. It was also a key vehicle for transporting mine clearing battalion equipment. The Army was issuing the M939A2 series 5-ton truck at the start of Operations Desert Shield and Desert Storm. The 1st Infantry Division was changed before its deployment. All other divisions deployed with a mix of vehicles. Only 1,185 of the 9,700 new M939A2 5-ton trucks were used in Operations Desert Shield and Desert Storm. There were 2,000 of the 3,800 M939A1 and 12,136 of the 45,800 older series trucks used.

Performance

The 2½-ton truck was the poorest performing vehicle in Operations Desert Shield and Desert Storm, because of its age and mobility problems. The 5-ton truck had mixed performance. The older vehicles did not perform as well as the newer vehicles, yet the operational readiness rates exceeded the Army's standard. The vehicles had varying degrees of mobility. The older M39, M809 and early M939 models with dual rear wheels did not perform as well as the M939A1, which has super single radial tires or the M939A2 which has central tire inflation system in addition to super single radial tires.

OBSERVATIONS

Accomplishment

- Newer M939A1 and M939A2 5-ton truck models performed better than older models and readiness rates exceeded Army standards.

Shortcoming

- The $2\frac{1}{2}$-ton truck was underpowered and experienced poor mobility.

Issues

- A family of medical tactical vehicles (FMTV) which is a 4X4 that contains a more powerful engine, super single radial tires, and central tire inflation system is being procured. Older 5-ton trucks will be replaced by the 5-ton FMTV version. Between the two versions of FMTV, the Army has developed a concept that will provide major component commonality and reduce parts stock problems.

- A Service Life Extension Program (SLEP) is required because new vehicles cannot be procured fast enough to replace older trucks. SLEP will provide a more powerful engine and super single radial tires resulting in greater reliability and increased mobility, while reducing operation and support costs.

TACTICAL WHEELED VEHICLES (LIGHT FLEET)

High Mobility Multi-purpose Wheeled Vehicle (HMMWV)

Mission

The light fleet TWVs deployed to Operations Desert Shield and Desert Storm consisted of the high mobility multi-purpose wheeled vehicle (HMMWV), combat unit cargo vehicle (CUCV) (a modified Chevrolet Blazer), the M-151 Jeep, the M561Gama Goat and the M880 Dodge pickup truck. The HMMWV is a light, highly mobile, diesel powered, tactical vehicle that uses a common 1-1/4 ton payload chassis. The HMMWV versions are: cargo/troop carrier, armament carrier, communications system carrier, ambulance, TOW missile carrier, and light artillery prime mover. The CUCV is a light commercial-type 4-wheel drive vehicle powered by the same engine as the HMMWV with 1-1/4 ton capacity and less mobility than the HMMWV. The CUCV was designed for use in units that operate in rear areas. The versions are: cargo, ambulance, communications shelter, and command vehicle. The

Jeep, Gama Goat and M880 are being retired. These vehicles were deployed with units to Southwest Asia (SWA) because the program to replace them had not been completed. All these type vehicles are expected to be out of the inventory by the end of FY 93.

System Data

HMMWV

Prime Contractor: AM General
Crew: Two to four
Initial Operational Capability: 1984
US Inventory: 59,883
Curb weight: 5,200 to 7,180 pounds (depending on model)
Payload: 2149 to 3177 pounds (depending on model)

Length: 180 to 203 inches
Width: 85 inches
Height: 72 to 105 inches
Propulsion: 6.2 liter diesel engine
Trailer towing capacity: 3,400 pounds
Range: 300 miles

CUCV

Prime Contractor: General Motors Corp, Chevrolet Division
Crew: Two
Initial Operational Capability: 1983
US Inventory: 58,604
Curb weight: 5,900 pounds
Payload: 2,900 pounds
Length: 185 to 222 inches (depending on model)
Width: 80 inches
Height: 76 to 101 inches (depending on model)
Trailer towing capacity: 3,000 pounds
Range: 250 miles

Employment

The Army used 20,000 of its 59,883 HMMWVs in Operations Desert Shield and Desert Storm. When the crisis began, the Army was replacing older vehicles with the HMMWV in its divisions and Armored Cavalry Regiments. The 82 Airborne Division and the 1st Infantry Division changes were completed before deployment. More than 5,000 HMMWVs were shipped to the theater to replace older vehicles in various units.

The Army also deployed 13,291 of its 58,604 CUCVs. In Operations Desert Shield and Desert Storm, operation of the CUCV was limited because of SWA's harsh terrain.

Performance

The HMMWV was the light vehicle of choice for soldiers in Operations Desert Shield and Desert Storm because of its superb performance. The HMMWV met or exceeded all expectations. It demonstrated excellent cross-country capability and its 90 percent operational readiness rate exceeded Army standards. The large payload capacity also was a tremendous asset for units. It proved to be a rugged cross-country vehicle. (The only complaint from soldiers was that the seat was too hard.) The CUCV had limited off-road capability and was not able to meet all the forward forces' requirements. However, it performed well when used within its limitations. The outdated M-151, M880 and Gama Goat did not perform well.

OBSERVATIONS

Accomplishments

- Versatile and reliable, the HMMWV maintained an operational readiness rate that exceeded Army standards. Its cross-country mobility and large payload capacity made it the light vehicle of choice among soldiers.

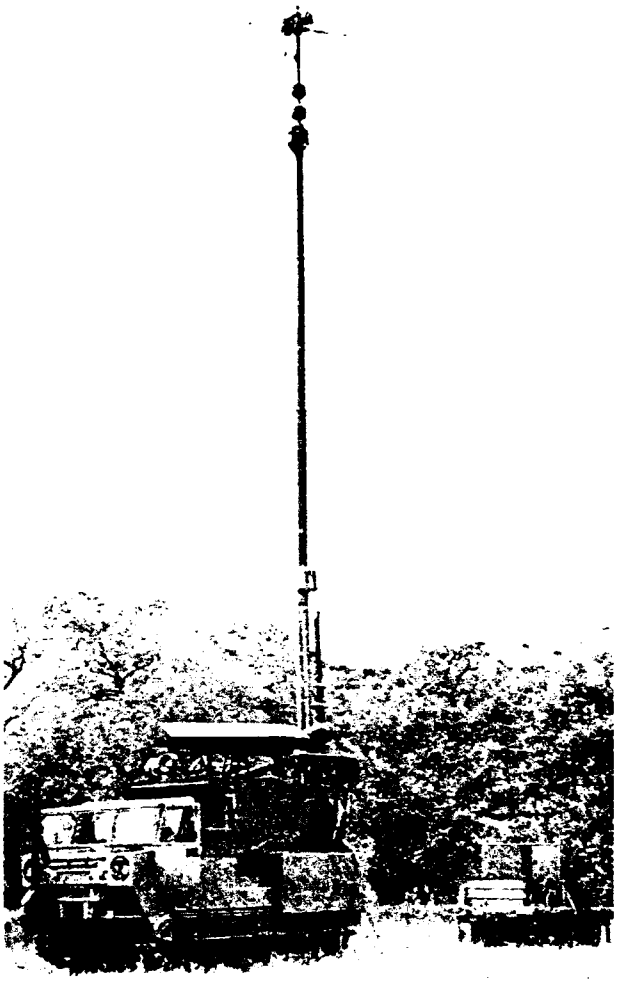
Shortcomings

- HMMWV's hard seat made rides uncomfortable for soldiers. HMMWVs in current production have a new seat that improves comfort. The Army also is installing new seats in the older vehicles.
- The CUCV had limited off-road mobility.

Issues

- A heavy HMMWV version intended to provide better artillery towing and transport heavy shelters will be fielded in FY 93.
- The Army is studying the possibility of installing tires that improve traction and, thus mobility, on the CUCV.
- Future procurements will favor HMMWV-like vehicles. However, there still is a role for a CUCV-type vehicle for units that operate in rear areas with improved roads.

TRAILBLAZER RADIO INTERCEPT AND DIRECTION FINDING SYSTEM



Mission

Trailblazer is a semi-automatic high frequency/very high frequency (HF/VHF) communications intercept and VHF radio intercept and direction finding (DF) system. It can locate a VHF transmitter within five seconds to a distance of approximately 30 km. It is targeted against Division and below command posts, maneuver, artillery and air defense units.

System Data

Frequency: 0.5-500 MHz (Intercept), 20-80 MHz (DF)
Targets: Single channel tactical HF and VHF tactical radios and jammers
Range: 30 KM (VHF); 70 + KM (HF)

Employment

Five Trailblazers deployed to Southwest Asia. In accordance with the deception plan and operational security policy, all systems were used initially in local force protection missions, rather than for collection operations against Iraqi forces.

Performance

When the Operation Desert Storm operations order required friendly forces to move to the west of the Iraqi forces, Trailblazer was used to confirm that selected breach routes were unopposed to a distance of 20 km. Targeting the few active enemy communications emitters, Trailblazer's DF system located Iraqi transmitters. However, the enemy's radio silence and the speed of the Coalition advance combined to limit Trailblazer's contribution after the ground offensive started. The Trailblazer, mounted on a Vietnam-era M1015A1 tracked carrier, could not keep up with the M1 tanks and M2 fighting vehicles.

OBSERVATIONS

Accomplishment

- Trailblazer provided accurate VHF emitter locations to 150 km.

Shortcomings

- The M1015A1 tracked carrier, common to Trailblazer, the Teampack Electronic Intelligence System, and the Tacjam Electronic Countermeasures System, is mechanically unreliable and lacks the mobility and speed to keep pace with the supported combat force.

Issue

- Corrective action is under way to mount Trailblazer on 5-ton trucks for speed and mobility. New systems are being designed for the Electronic Fighting Vehicle System, which will be mounted on a Multiple Launch Rocket System chassis.

TROJAN SPIRIT SATELLITE COMMUNICATIONS SYSTEM

Mission

Trojan Spirit is a mobile satellite communications system mounted on a High Mobility Multi-purpose Wheeled Vehicle (HMMWV) providing Sensitive Compartmented Information-level communications and automation for all-source intelligence purposes. Trojan Spirit's mission is to provide voice, data, and facsimile communications at Army component, corps, division, separate brigade, armored cavalry command posts (CP) and maneuver brigades, and organic or assigned intelligence units, linking them with supporting or supported intelligence units both in the continental US and overseas.

System Data

Prime Contractor: Electrospace Systems
Initial Operational Capability: 1991
Configuration: One HMMWV with two trailers (satellite terminal and power generation) or in two HMMWVs
Communications: C and Ku-Band capable. Uses leased and government-owned satellite channels for worldwide connectivity

Employment

Army Component, Central Command (ARCENT) used the total production run of 13 Trojan Spirit systems in Operations Desert Shield and Desert Storm in Southwest Asia. ARCENT used three Trojan Spirits at the component Main and Mobile CPs. One provided all-source collection management and intelligence dissemination support from the echelon above corps intelligence center at the ARCENT Main CP (Riyadh) to the VII Corps and XVIII Airborne Corps and the theater reserve division (1st Cavalry Division).

XVIII Airborne Corps used one Trojan Spirit at its Main CP, using it for all-source intelligence and for communicating to the system used at the 101st Airborne Division (Air Assault) subordinate to the corps.

VII Corps used two Trojan Spirits, one at its Main CP and one at its Military Intelligence Brigade Operations Center at another location. These systems provided all-source intelligence and imagery intelligence support to the Commander, VII Corps, and communicated with systems at VII Corps divisions.

ARCENT also provided one Trojan Spirit to Marine Corps Component Comander (MARCENT) for all source connectivity to ARCENT, since ARCENT was responsible for ground order of battle in the theater.

Performance

Overall readiness rates for Trojan Spirits, first fielded in mid-January before the air campaign began, was more than 90 percent. Key intelligence support was provided by Trojan Spirit:

- Allowed ARCENT to inform both US corps the Iraqi Republican Guards divisions were moving to block ARCENT's attack; influenced the disposition of the attacking forces in both US corps;

- Provided the only means to communicate intelligence on the enemy situation from the ARCENT to 1st Cavalry Division once the division began its rapid, cross-desert attack as theater reserve against the Republican Guards;

- Provided a means to communicate imagery from VII Corps' supporting MI Brigade to the 1st Armored Division, allowing the division to attack some 20 targets with artillery and attack helicopters;

- Linked the 101st Airborne Division (Air Assault) with the XVIII Airborne Corps after the division assault into Iraq, with its Trojan Spirit deployed and

operating in position near the Euphrates River. In this manner, XVIII Airborne Corps could warn 101st Airborne Division (Air Assault) of any threat approaching the division's position from Baghdad;

- Provided a rapid, reliable, secure means of intelligence dissemination and collection management from division through component level, at times the only means of communicating intelligence information to mobile forces. This occurred when immediate precedence record traffic via AUTODIN took eight to 12 hours to reach addressees. During the air campaign, this connectivity was particularly important to 1st Cavalry Division, in blocking position and performing raids across the Iraq-Kuwait border, as other US forces moved to attack positions;

- During the air campaign, provided a means to communicate intelligence on Iraqi movements and battle damage between ARCENT and the two corps, and MARCENT.

OBSERVATIONS

Accomplishment

- Provided a rapid, reliable, secure means of intelligence dissemination and collection management from division through component level, at times the only means of communicating intelligence information to mobile forces.

Shortcomings

- Not every division had a system, and units typically received only one of three required.
- Lacked tactical mobility of the satellite terminal trailer, and time to integrate the system into unit operations.

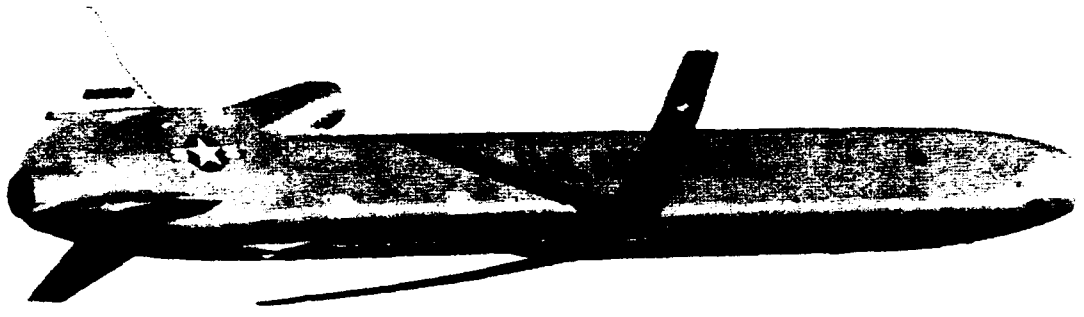
Issue

- A proposal to field and integrate a modified version, adapted for mobility, and with new satellite channels to Army Force Package One units in sufficient quantities is being considered.

APPENDIX T. Performance of Selected Weapon Systems

MUNITIONS

AIR-LAUNCHED CRUISE MISSILE



Mission

The AGM-86C air-launched cruise missile (ALCM) was designed to attack soft ground targets using a high explosive blast/fragmentation warhead. It is a conventional variant of the AGM-86B nuclear ALCM. A global positioning system (GPS) aided by an inertial navigation system (INS) provides all-weather capability.

System Data

Prime Contractor: Boeing Aerospace
Initial Operational Capability: 1988
Length: 20 ft, 9 in
Wingspan: 12 ft
Cruise Speed: 500 mph
Propulsion: Williams F107-WR-101 turbofan
Guidance: GPS/INS
Armament: Blast/fragmentation

Employment

During the first night of Operation Desert Storm, 35 conventional ALCMs were launched from seven B-52G aircraft which took off from Barksdale AFB, LA. The bombers launched the missiles on the one-time mission approximately two hours after the strategic air campaign began. These ALCMs were launched against 8 targets in Iraq, including power generation and transmission facilities and military communications sites.

Performance

A complete assessment of the AGM-86C's effectiveness is difficult to determine because of incomplete battle damage assessment (BDA) and the inability to distinguish damage caused by other munitions that struck some of the same targets. All missiles launched successfully transitioned to cruise flight. Demonstrated accuracy appears consistent with the results obtained from testing.

OBSERVATIONS

Accomplishments

- The AGM-86C ALCM played an important role in Operation Desert Storm.
- All missiles that were launched successfully transitioned to cruise flight.

LASER GUIDED BOMBS (LGB)

Mission

Laser-guided bombs (LGBs) are close-in weapons capable of striking point targets. There are three weight classes of LGBs: 500 lb, 1000 lb, and 2,000 lb. The weapon consists of a bomb body with a guidance kit which detects a target illuminated by a laser beam.

System Data

Prime Contractor: Texas Instruments
Initial Operational Capability: Early-1970
Range: Up to 7 miles
Guidance: Passive laser tri-Service seeker.
Armament: Blast fragmentation high explosive warhead (500, 1,000, and 2,000 lb), or penetrator (BLU-109 Improved 2000 lb)

Employment

LGBs delivered by the F-111, F-15E, F-117, F/A-18, and the A-6E were used primarily against hardened airfield facilities, such as aircraft shelters and bunkers, and also against bridges, artillery and armor. The GBU-12 (500 lb) was used extensively against vehicles and armor. All LGBs were used against point targets because of their high accuracy.

Performance

Approximately 9,300 LGBs were dropped. More than 4,500 of these were GBU-12 (500 lb); over 2,500 were GBU-10 (2,000 lb); over 200 were GBU-16 (1,000 lb), and almost 2,000 were GBU-24/27 (1,600 of which were 2,000-lb penetrators).

Although there is a lack of comprehensive bomb damage assessment data, LGBs appear to have performed well. After action reports indicate the LGBs were effective. Because of their precision, LGBs were the weapon of choice when accuracy was required, such as against military targets in downtown Baghdad and bridges. While there were some instances of weapons failing to guide; overall, LGBs were responsible for minimizing collateral damage.

LGBs used against tanks and armored vehicles, hardened command and control bunkers, and aircraft shelters were also effective. However, while post war examination and analysis of Iraqi targets confirms the success of LGBs, battle damage assessment (BDA) by reconnaissance assets during the conflict was difficult to determine. LGBs would often penetrate into the facility leaving only a small penetration hole although interiors were determined to have been destroyed or severely damaged. Further data on precision-guided ordnance effectiveness is unavailable unless an extensive bomb damage assessment study is completed.

OBSERVATIONS

Accomplishment

- Demonstrated LGB accuracy was consistent with results from pre-war testing.

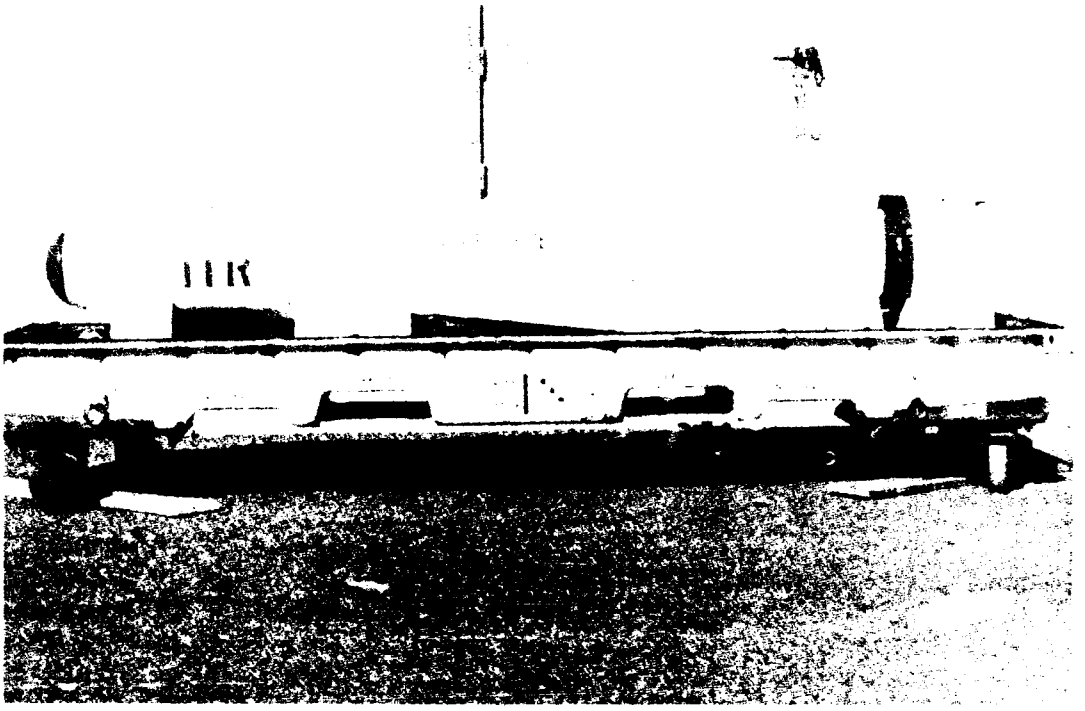
Shortcoming

- There were some shortages of LGB guidance kits in theater.

Issue

- Additional LGB kits are being procured to build up the operational inventory.

MAVERICK AIR-TO-GROUND MISSILE



Mission

Maverick is a stand-off weapon capable of striking point targets. There are six variants. Maverick A and B versions have an electro-optical (EO) television guidance system. The D and F variants have an imaging infrared (IR) guidance system operated much like that of the A or B, except that infrared video overcomes the daylight only limitation. The E variant uses a laser seeker to guide against designated targets such as protected command bunkers and armored vehicles. Laser designation can be performed by ground Modular Universal Laser Emitter (MULE) or airborne systems. The F and G variants have essentially the same guidance system as the D with a heavier weight penetrator warhead in the F and G variants.

System Data

Prime Contractor: Hughes/Raytheon
Initial Operational Capability: AGM-65D in 1983; AGM-65F/G in 1989
Length: 8.8 ft
Cruise speed: Supersonic
Range: Up to 15 miles
Propulsion: Single stage solid propellant rocket motor with dual thrust
Guidance: Television (AGM-65A/B); Laser Maverick (AGM-65E) - Passive laser tri-Service seeker; IIR Maverick (AGM-65D/F/G) - Passive imaging infrared seeker with digital centroid tracking
Armament: Shape-Charge Jet and Blast 125 pound warhead (A/B/D); blast fragmentation 300 lb high explosive warhead (E/F/G)

Employment

The Maverick can be used from the A-6, A-10, AV-8B, F-16, F-4G, and F/A-18. The missile has a launch and leave capability that lets a pilot fire the weapon and immediately take evasive action or attack another target. The shape-charge jet and blast warhead is designed to work against armor and other moderately hard targets but can also be effectively used against targets such as radar control facilities and other above-ground facilities.

Maverick attacks were conducted typically in close air support (CAS) or air interdiction (AI) missions. Both IR and TV Mavericks were used. Most were fired at ranges averaging 3.5 miles or less, which is considerably less than the weapon's maximum range. The predominant target set for IR Maverick was armor. Attack aircraft in many cases would be assigned to a "kill box" in which an airborne Forward Air Controller (FAC) would also be assigned. The FAC would enter the Kill Box to find the targets. Attack aircraft would then be directed to the target by the FAC.

Performance

Maverick success rate (successful launch and guidance to the target) was approximately 80 to 90 percent for the more than 5,100 AGM-65s fired. These results are consistent with Air Force performance before Operation Desert Storm. Laser Maverick performance was reported as three hits for five missiles fired. The misses were attributed to weak MULE batteries.

OBSERVATIONS

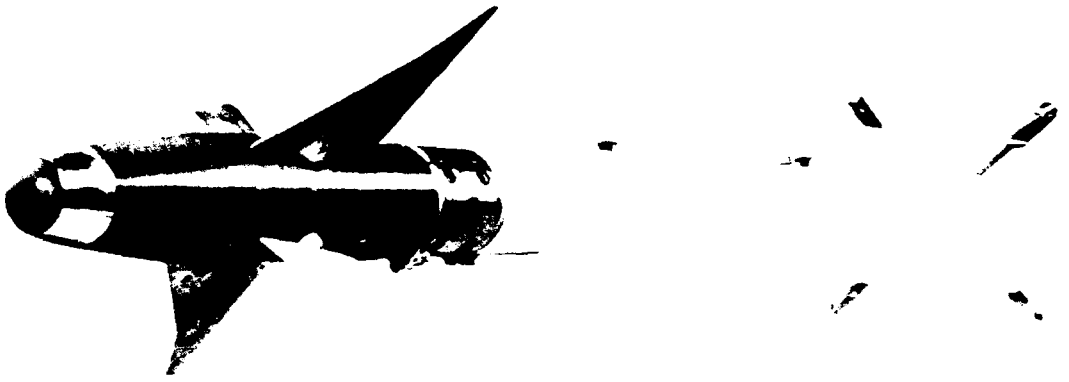
Accomplishments

- A-10s delivered more than 4,800 of the more than 5,100 Mavericks used in the war.
- Maverick demonstrated accuracy consistent with results from pre-war testing.

Shortcoming

- Maverick use requires comprehensive training because of the cockpit workload in the battlefield environment. This can cause aircrews to become unduly preoccupied and predictable targets for enemy anti-aircraft fire while attempting delivery.

SIDEWINDER AIR-TO-AIR MISSILE



Mission

The AIM-9 Sidewinder is an advanced, short-range, supersonic, air-to-air missile. The AIM-9 Sidewinder's primary role is air superiority, but the missile also is used extensively to provide aircraft self defense capability. The Sidewinder uses a passive infrared (IR) target acquisition system.

System Data

Prime Contractor: Ford Aerospace
Initial Operational Capability: 1982 (AIM-9M)
Length: 9 feet, 5 inches
Diameter: 5 inches
Wingspan: 2 feet, 0.75 inches
Weight: 195 lbs
Warhead: AIM 9L, 20.8 lbs; AIM-9M, 7.4 lbs blast fragmentation
Propulsion: Solid propellant rocket motor
Guidance: Passive IR homing

Employment

The AIM-9 Sidewinder missile was used within visual range, day and night, in clear weather.

Performance

A small number of Sidewinders (less than 20) were fired during Desert Storm. Success rate of the AIM-9 was consistent with the results of previous testing. More realistic pilot training and improved missile technology played major roles in the missile's success.

OBSERVATIONS

Accomplishment

- The Sidewinders fired during Desert Storm performed well and the success rate was consistent with previous operational testing.

SPARROW AIR-TO-AIR MISSILE

Mission

The AIM-7 Sparrow is a semi-active radar-guided, air-to-air missile with a high-explosive warhead. It has all-weather, all-altitude operational capability and can attack high performance aircraft from all angles, including head-on. With its quick reaction time and high maneuverability, the Sparrow can attack targets traveling at supersonic speeds and at all altitudes. The missile also can operate in an electronic countermeasures environment. It can be carried on the F-14, F/A-18, F-15, Air Defense F-16,and F-4G.

System Data

Prime Contractor: Raytheon
Initial Operational Capability: 1983 (AIM-7M)
Weight: 500 lbs
Length: 12 ft
Diameter: 8 in
Wingspan: 40 in
Warhead: High explosive, 85 lbs
Guidance: Radar, semi-active continuous wave or pulsed doppler

Employment

The Sparrow was used by F-14, F-15, and F/A-18 aircraft during Operation Desert Storm. The missile was used both day and night, in clear or adverse weather, in visual and beyond visual range (BVR) tactical situations. Improved performance can be attributed to realistic pilot training programs such as Red Flag and Top Gun, as well as cockpit display technology.

Performance

There were 71 AIM-7 Sparrow firing attempts. The Air Force (USAF) accounted for 67 of the 71 attempts. USAF hit rate was nearly triple the success rate in Southeast Asia (SEA). The Navy's experience was similar.

Results most likely were due to several factors. The AIM-7M is much improved over earlier versions. The success rate of Sparrows launched within the missile's envelope was double the success rate in SEA. A larger percentage of the launch attempts were in the envelope and a much greater percentage were successful against targets at low altitude. Some firings were successful against helicopters.

OBSERVATIONS

Accomplishments

- Technological improvements to the Sparrow resulted in improved performance.
- Realistic advanced fighter weapons training at Service training schools resulted in improved pilot performance.
- Combat results show previous Weapons System Evaluation Program test firings conducted by the Services in peacetime to have been fairly accurate at depicting pilot, aircraft, and air-to-air missile capabilities and limitations.

STANDOFF LAND ATTACK MISSILE (SLAM)

Mission

The Standoff Land Attack Missile (SLAM) is a tactical weapon designed for deployment aboard aircraft carriers. Launched from A-6E and F/A-18 aircraft, it provides a standoff air-to-surface day/night/marginal weather capability. It satisfies intermediate tactical needs between long-range cruise missiles and short-range freefall munitions in land attacks against fixed, above-ground, high-value targets.

System Data

Prime Contractor: McDonnell Douglas Missile Co.
Initial Operational Capability: Pre-Initial Operational Capability Deployment
Length: 14.75 ft
Weight: 1385 pounds
Cruise Speed: MACH 0.8
Range: More than 50 miles
Propulsion: Turbojet engine
Guidance: Target location and mission data are loaded into the missile before takeoff. While the missile is in-flight, a satellite Global Positioning System (GPS) receiver/processor updates the missile's inertial navigation system. This points the missile's imaging infrared (IR) seeker directly at the target. The IR seeker sends a video image to the cockpit via a Walleye data link pod. The pilot selects a specific aimpoint on the target and gives the commands for seeker lock on. After seeker lock on, the missile makes an autonomous precision strike.
Armament: 500 lb high explosive
Fuze: Provides instantaneous and delayed detonation options

Employment

SLAM was used to attack heavily defended targets from standoff ranges outside of surface-to-air missile and antiaircraft artillery envelopes.

Performance

Seven SLAMs were launched from either A-6E or F/A-18 aircraft at standoff ranges outside Iraqi target defenses. Missiles were controlled from A-7E or F/A-18 aircraft through AWW-9 data link pods.

The new AWW-13 data link pod was unavailable for use, requiring the use of the older, less reliable AWW-9 pod. Initial AWW-9 pod reliability was low, requiring dedicated maintenance efforts by a team of civilian technicians and Navy maintenance personnel to improve performance.

OBSERVATIONS

Accomplishments

- SLAM provides a standoff capability and was used successfully for the first time in combat without the loss of aircraft or crew.
- Recorded infrared video of the missile as it struck the target provided verification of aimpoint accuracy (BIA - bomb impact assessment).

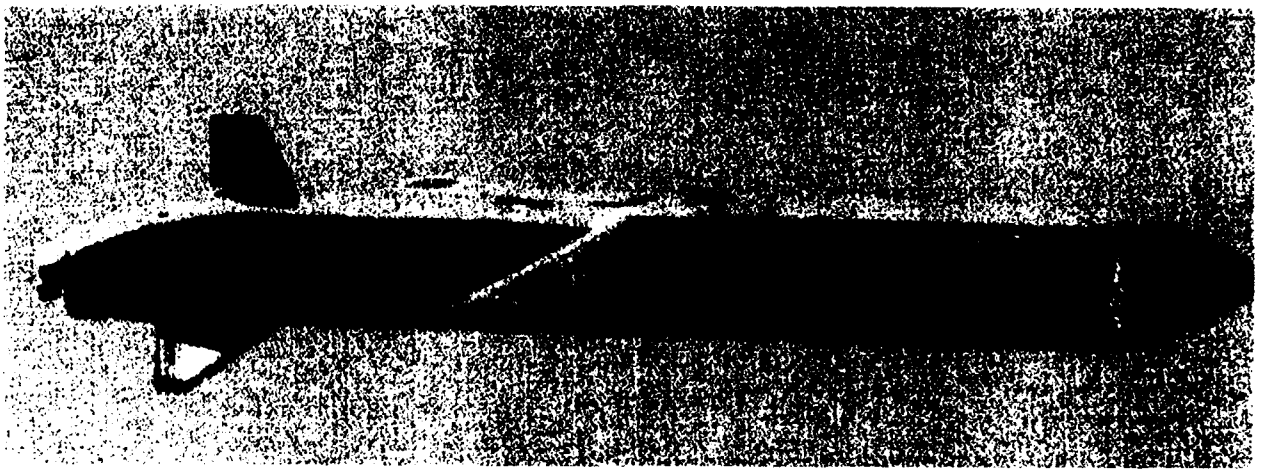
Shortcoming

- The AWW-9 data link pod was unreliable.

Issue

- The new AWW-13 advanced data link pod currently entering the Fleet should resolve data link pod reliability problems.

TACTICAL AIR-LAUNCHED DECOY



Mission

The ADM-141 Tactical Air-Launched Decoy (TALD) is an expendable aerial decoy used to improve strike aircraft survivability by deceiving and saturating hostile radar-controlled air defenses.

System Data

Prime Contractor: Brunswick Defense Corp.
Initial Operational Capability: 1987
Weight: 400 lbs
Length: 7.67 ft
Maximum Range: 86 miles at maximum launch altitude/minimum decoy speed
Launch Platforms: F/A-18, A-6, A-7, S-3
Launch Altitude: 100 to 40,000 ft
Speed: 250 to 500 knots
Radar Return Enhancement: Active and passive

Employment

TALDs are small, unpowered decoys carried by tactical aircraft on standard bomb racks. TALD's size, weight and carriage approximate that of a 500-lb bomb. Up to eight TALDs can be carried by a single Navy or Marine (USMC) aircraft.

Significant numbers of TALD were used in the early stages of Operation Desert Storm supporting suppression of enemy air defenses (SEAD) operations. TALD was launched by both Navy and USMC tactical aircraft and were used in varying quantities in both dedicated TALD missions and combined TALD/Strike payloads.

Performance

TALD proved to be a key element in the suppression arsenal. Pilots reported SAMs were launched in response to TALD launches. Furthermore, it is likely that TALD contributed to Iraqi claims of massive Coalition aircraft losses early in the theater campaign.

OBSERVATIONS

Accomplishments

- Southwest Asia (SWA) provided the first combat use of TALD. Despite a lack of experience with the weapon system, it was easily loaded by loading crews and deployed by aircrew.
- TALD was an integral part of SEAD strike planning. Aircrew confidence in the weapon system increased as a result of battlefield observation of its effectiveness.
- TALD probably was responsible for the early Iraqi claims of extensive allied aircraft losses.
- TALD exposed enemy SAM site radars and made them more susceptible to HARM.

Shortcomings

- TALD launch and carriage restrictions placed some aircraft within the range of long-range SAMs.
- While TALD was extremely effective against the Iraqi integrated air defense systems, the glide path might be more easily discriminated by more sophisticated radars or operators.

TOMAHAWK MISSILE

Mission

Tomahawk is a stand-off, deep strike weapon capable of striking ships and targets ashore from surface combatants or submarines. Tomahawk's objective is to deliver pinpoint attacks against targets in heavily defended areas where the probability of the loss of manned aircraft is too high.

There are three conventionally-armed Tomahawk variants:

Tomahawk Antiship Missile (TASM) (BGM-109B) contains a guidance system similar to the Harpoon anti-ship missile. TASM uses an active radar seeker and passive identification and direction-finding equipment to seek out, lock on, and strike targets ranging from frigates to high value carriers. Its sea-skimming altitude and evasive flight path help the missile conceal the direction of its launch and elude enemy defenses as it approaches the surface target.

TLAM-C (BGM-109C) can neutralize important targets ashore, such as command and control (C2) systems, airfields, and air defense systems with its 1,000-lb warhead.

Submunition TLAM-D (BGM-109D) is a variant of the TLAM-C, can strike area targets and can render aircraft and air defense sites inactive. It can attack multiple targets by dispensing 166 combined effects bomblets (CEB) submunitions in partial loads which provide armor-piercing, fragmentation, and incendiary effects.

System Data (TLAM-C/D)

Prime Contractor: McDonnell/Douglas; General Dynamics
Initial Operational Capability: 1986 (TLAM-C)
Length: 20.5 feet
Cruise speed: High subsonic (Mach 0.5 to .75)
Range: Greater than 500 miles
Propulsion: Solid propellant rocket motor for boost mode; turbofan engine for cruise mode
Guidance: Terrain-Contour Matching (TERCOM) uses a radar altimeter to produce terrain profiles at preselected points along the route. These profiles are compared with reference maps in the guidance computer to determine if flight corrections are needed. Each TERCOM update increases the precision of TLAM's flight; Digital Scene-Matching Area Correlation (DSMAC); more precise than TERCOM, produces digital scenes of natural and man-made terrain features and compares them with scenes stored in a computer. Used during terminal homing phase to guide TLAM-C/D to a direct hit.
Armament: TLAM-C – 1000-lb high explosive, TLAM-D – 166 BLU-97/B combined effects bomblets in 24 packages

Employment

Only the TLAM-C and D variants were used during Operation Desert Storm. TLAM's employment emphasized its primary attributes – precision strike capability and survivability. It was one of only two systems used to strike targets in downtown Baghdad – the most heavily defended target complex – during the initial phase of

the air campaign. Tomahawk was the only weapon used for daylight attacks against Baghdad during the entire campaign.

TLAM missions were an integral part of the air campaign. They were fully integrated into the daily Air Tasking Order with other air assets. Unlike tactical air strikes, however, TLAM missions did not require Airborne Warning and Control System (AWACS), tanker, fighter or electronic warfare coordination. As a result, TLAM sometimes was the only asset that could conduct short notice strikes (provided that a TLAM mission package already had been prepared). For example, when suspected Scud missile loading activity was detected at a missile storage facility, 13 TLAM were fired at previously attacked aimpoints to disrupt the activity until tactical air strikes could be conducted.

Overall, 282 of 288 Tomahawks were successfully launched by 16 surface ships and two submarines. Of these, 64 percent were launched during the first 48 hours of the war. These strikes were almost exclusively against chemical weapons facilities, electrical power and distribution facilities, and high level leadership C2 facilities. The attacks on leadership and C2 facilities paved the way for Coalition aircraft to strike Baghdad and other heavily defended areas.

Performance

Mission planners at the Cruise Missile Support Activities, located at Atlantic and Pacific commands, began planning targets soon after the invasion of Kuwait. Throughout Operation Desert Shield, planners continued to develop TLAM strike missions and plans. By H-Hour, with the assistance of national sensors to supplement existing information, several hundred TLAM missions were available to support the air campaign.

The key to timely mission planning was the availability of TERCOM maps from the Defense Mapping Agency and DSMAC scenes based on recent imagery. Once missions are transmitted to Tomahawk platforms, missiles can be ready to fire very quickly. Tomahawk targeting capability against relocatable targets was demonstrated in one instance by a short notice attack against an Iraqi communications facility. Although Tomahawk is affected by some types of adverse weather, weather conditions during Operation Desert Storm never precluded a TLAM mission.

Of 288 missiles launched, 282 successfully achieved cruise flight for a 98 percent launch success rate. An assessment of TLAM effectiveness – its success in reaching and damaging the intended target – is much more difficult to determine because of incomplete battle damage assessment (BDA) and the inability to distinguish missile damage from damage caused by other assets, including other Tomahawks. During Operation Desert Storm, Tomahawk was sometimes used to disrupt functions in a target facility, rather than to destroy the facility. TLAM also

was used only to damage a facility to a level that would require a moderate period of time to repair instead of complete destruction.

All assigned TLAM missions were executed either by the first-assigned platform using the intended missile or its backup, or by reassigning the mission to another launch platform. On several occasions, Navy Component Central Command (NAVCENT) elected not to use backup missiles, or another platform, because the missile was one of several targeted at the designated aim point and sufficient redundancy existed.

TLAM's demonstrated accuracy was consistent with results from pre-combat testing. The observed accuracy of TLAM, for which unambiguous target imagery is available, met or exceeded the accuracy mission planners predicted.

OBSERVATIONS

Accomplishments

- The Tomahawk cruise missile played an important role as the only weapon system to attack central Baghdad in daylight. The cruise missile concept, incorporating an unmanned, low-observable platform able to strike accurately over long distances, was validated as a significant weapon for future conflicts.

- The demonstrated launching system success rate was 98 percent.

- TLAMs demonstrated accuracy that was consistent with results from pre-combat testing.

Issue

- Block III missile improvements, planned well before the invasion of Kuwait, are funded in the FY92 budget. Significant improvements in Tomahawk C2 systems included with the Block III improvements will be fielded in 1993. These improvements will increase flexibility and reduce communication requirements associated with targeting conventional Tomahawk missions.

- Additional improvements in the Tomahawk weapons system based upon experience gained during Operation Desert Storm are under review for inclusion in Tomahawk Block III missile development.

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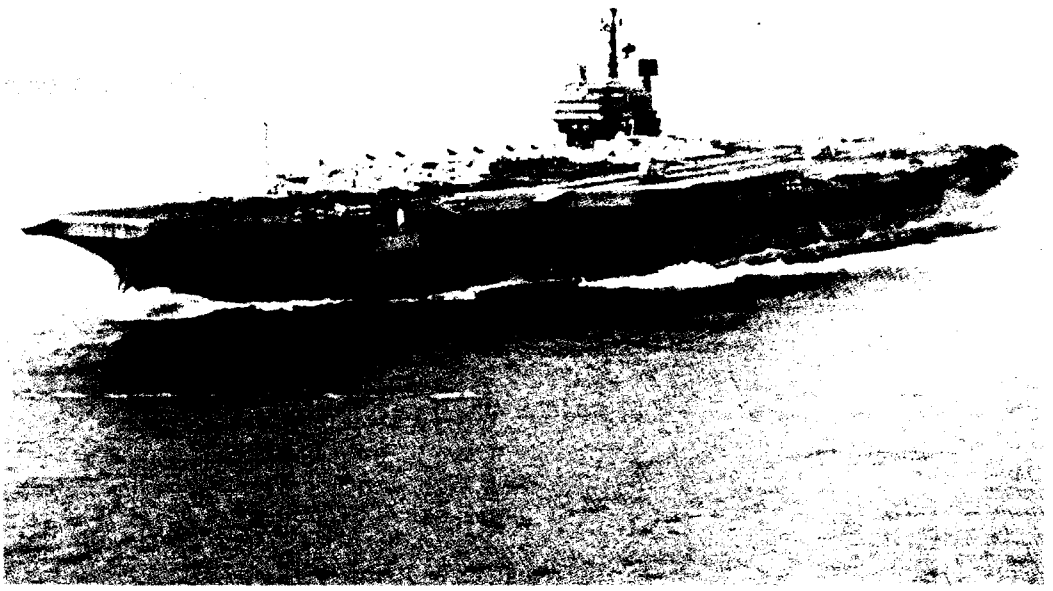
APPENDIX T. Performance of Selected Weapon Systems

NAVAL SYSTEMS

AIRCRAFT CARRIER (CVICVN)



Mission

The aircraft carrier's mission, as the center piece of the Navy's battle group, is to conduct prompt and sustained combat operations at sea, through sea control and power projection. In the exercise of sea control, the carrier and its embarked aircraft can, under all conditions of weather and visibility, detect and destroy enemy aircraft, submarines, and surface ships; strike base areas; and conduct reconnaissance, patrol, and offensive mining operations. In the exercise of power projection, the carrier strikes enemy air and naval bases and port facilities; conducts interdiction strikes and close air support in conjunction with amphibious operations and land campaigns; and conducts deep strikes against the enemy's infrastructure and strategic targets.

There are two aircraft carrier variants, the conventionally powered aircraft carrier (CV) and the nuclear powered aircraft carrier (CVN). The newer, more capable CVNs are replacing older conventional CVs in the fleet.

System Data (Nimitz Class)

Length overall: 1,092 ft
Beam, maximum: 257 ft
Full Load displacement: 96,300 tons
Aircraft embarked: 85 to 90
Aircraft Catapults: Four
Complement: 6,300
Propulsion Plant: Nuclear power
Speed: 30 + knots

Employment

At the time of the Iraqi invasion of Kuwait, the Navy already was on station in the region. Battle Groups led by *USS Independence* (CV 62) and *USS Dwight D.Eisenhower* (CVN 69) moved from the Indian Ocean and Eastern Mediterranean Sea to take up positions in the Gulf of Oman and Red Sea respectively – ready to begin sustained combat operations.

When Operation Desert Storm began, there were six aircraft carriers on station in the Red Sea and Persian Gulf. *USS America* (CV 66) and *USS Theodore Roosevelt* (CVN 71) left Norfolk on 28 December, and arrived on station just before Operation Desert Storm. They joined *USS Midway* (CV41), *USS Saratoga* (CV 60), *USS John F.Kennedy* (CV 67), and *USS Ranger* (CV 61), which already were on station.

Performance

Navy carrier-based aircraft contributed to the destruction of Iraq's air and naval forces, antiair defenses, ballistic missile launchers, communications networks, electrical power systems, and more.

E-2C Hawkeyes (discussed separately in this appendix) operated around the clock in conjunction with Coalition Airborne Warning and Control Systems to track Iraq's air force and provide air traffic control. Navy carrier-based aircraft flew continuous combat air patrols to protect Coalition naval forces, sealift shipping and airfields, and provided reconnaissance.

Carrier-based aviation made a major contribution to the destruction of the Iraqi Navy. Within the first three weeks of the air campaign, A-6s, F/A-18 and S-3s sank and disabled many of Iraq's missile gunboats, minesweepers, patrol craft and

other small ships. Silkworm antiship missile sites and armed hovercraft also were attacked.

Operation Desert Storm marked the first combat use of some of the Navy's newest carrier-based aircraft including the F-14A +, the F/A-18C, and the F/A-18D night-attack aircraft. S-3B aircraft also used their inverse synthetic aperture radar to locate mobile Scud launchers.

As the war progressed, the Navy's strike mission changed from strategic air attacks and battlefield preparation to tactical targets and battlefield air interdiction. On the last full day of war, the six carrier battle groups flew 600 combat missions. Nearly 20,000 carrier-based sorties were flown delivering more than 21 million pounds of ordnance.

OBSERVATIONS

Accomplishments

- Within one hour of the start of the 2 August attack, the *USS Independence* (CV 62) battle group (forward-deployed to the Indian Ocean) and the *USS Dwight D.Eisenhower* (CVN 69) battle group (forward-deployed to the eastern Mediterranean Sea) were ordered to the Gulf of Oman and the Red Sea, respectively.

- The flexibility of the aircraft carrier allowed for the concentration of air power where it was most needed. For example, *USS America* redeployed from the Red Sea, where it had been used to attack Baghdad and western Iraq, to the Persian Gulf where it could be used to support the ground campaign.

- The centralized location of all required strike assets (i.e., fighters, bombers, electronic warfare support aircraft, etc) on an aircraft carrier allowed an entire strike package to plan and prepare for complex strikes. This capability also provided an effective, rapid reaction strike capability if a short-notice contingency strike was required.

- Carrier-based aircraft flew approximately 20,000 sorties from 17 January to 28 February.

Shortcomings

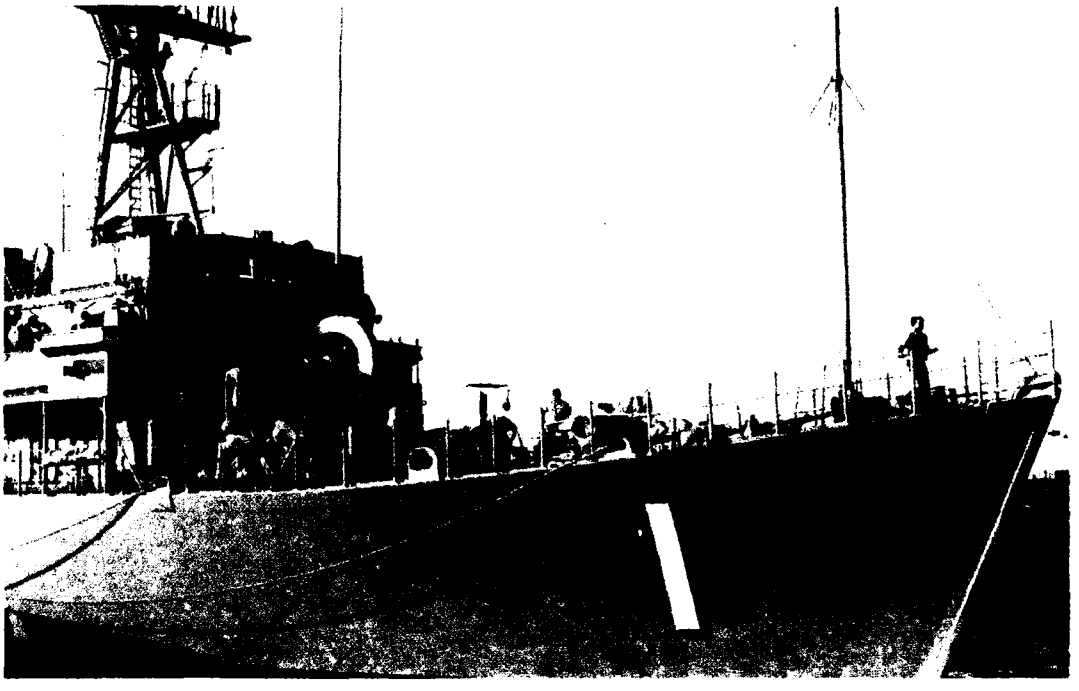
- Because of the extended ranges involved during attacks on Iraq, naval air assets required refueling from land-based tankers. However, the Persian Gulf Battle Force was able to move closer to Kuwait as the war progressed, which reduced the need for non-organic tanking support.

- For safety reasons, naval aircraft use JP-5 fuel for carrier-based operations. Refueling from land-based aircraft with other than JP-5 allowed mission completion, but presented an increased fire hazard when the aircraft returned to its aircraft carrier.

Issue

- The Navy and Air Force have established a flag-level board to address many issues involved with joint operations, such as in-flight refueling and fuel compatibility.

MINE COUNTERMEASURES SHIP



Mission

The surface mine countermeasures ship (SMCM) provides the capability to conduct a mine survey of harbors, port approaches, large ocean areas, including potential amphibious objective areas and sea lines of communication. These platforms can detect, locate and neutralize all existing types of bottom and moored mines.

System Data (MCM 1 Avenger Class Mine Countermeasure Ship)

Prime Contractor: Peterson Builders/Marinette Marine
Initial Operational Capability: 1987
Inventory: 14 (Planned)
Length: 224
Displacement: 1,312 tons
Beam: 39 ft
Draft: 11.5 ft
Speed: 14 knots
Complement: Six officers, 75 enlisted
Propulsion: Four diesel engines
MCM Systems: AN/SLQ-48 Mine Neutralization System,
AN/SSN-2 Precision Inertial Navigation System (PINS)
AN/SQQ-32 advanced minehunting sonar
AN/SLQ-37 influence minesweeping system
AN/WQN-1 channel finder
Armament: None

Employment

The US mine warfare concept was designed around a European war scenario, which relied on North Atlantic Treaty Organization (NATO) allies to participate substantially in mine warfare operations, especially in MCM. The Navy's MCM capabilities in the Persian Gulf consisted of surface mine countermeasures (SMCM), aviation mine countermeasures (AMCM), and explosive ordnance disposal (EOD) teams. One newly commissioned Avenger class (MCM 1) MCM ship and three older MSO 422/508 class minesweepers deployed to the Persian Gulf on 30 September. After Operation Desert Storm began, the Coalition mine countermeasures (MCM) forces cleared paths to the Kuwaiti coast for naval gunfire support and amphibious operations. After the cease fire, these platforms cleared port approaches and harbors, including Kuwait City's port.

USS Avenger (MCM 1) used the AN/SQQ-32 MCM sonar to detect moored and bottom mines in shallow or deep waters. *USS Avenger* also used the AN/SLQ-48 mine neutralization system (MNS) to locate, examine, and destroy mines. The MNS consists of a remotely piloted submersible vehicle equipped with sonar and two television cameras for locating mines, explosives for neutralizing mines, and cable cutters for cutting a mine's mooring so it floats to the surface for destruction. The other US minesweepers used the AN/SQQ-14 MCM sonar to detect bottom and moored mines and mechanical minesweeping gear to cut mine cables.

Performance

USS Avenger developed engineering problems while deployed; all four diesels engines had to be replaced during her deployment. However, *USS Avenger*'s MCM suite was effective. For example, on 27 February, *USS Avenger*, using the AN/SQQ-32 MCM sonar, detected, classified and marked a bottom influence mine (similar to the type that struck *USS Princeton*) at a distance of 900 yards. Because of the mine's unique shape and construction (glass reinforced plastic), it had been assessed to be undetectable by sonar. The AN/SLQ-48 was the most sophisticated mine neutralization system used in MCM operations and PINS proved to be the most precise and reliable navigation system of all Coalition MCM assets.

OBSERVATIONS

Accomplishments

- *USS Avenger*, using the AN/SQQ-32 MCM sonar, detected, classified, and marked a bottom influence mine similar to the type that struck *USS Princeton*.

- The AN/SLQ-48 was the most sophisticated MNS used in MCM operations and PINS proved to be the most precise and reliable navigation system of all Coalition MCM assets.

Shortcomings

- The SMCM ships lacked a dedicated support ship for C3, logistic, maintenance, and explosive ordnance disposal team support.

- *USS Avenger*'s as-received material condition was poor. This shortcoming initially prevented her from contributing the most sophisticated and effective MCM systems to the Coalition's MCM operations.

NAVAL GUNFIRE SUPPORT (NGFS)

Mission

Iowa Class battleship 16-inch/50 caliber guns provide intermediate-range naval gunfire support (NGFS) for battlefield area interdiction (BAI) and direct support for forces ashore. Each 16-inch gun can fire a 2,700-lb armor-piercing shell more than 23 miles every 30 seconds. A battleship can deliver more than 20 tons of ordnance on target in one minute and 1,458 tons in one hour.

System Data

Calibre: 16 inch
Projectile weight: 2,240 lbs; 2,700 lbs armor piercing
Rate of Fire: Two rounds per minute/one per minute sustained
Maximum range: 26 miles
Maximum effective range: 20 miles
Rounds per ship: 1220
Guns per battleship: Nine

Employment

During Operation Desert Storm, the Navy's two commissioned battleships, *USS Missouri* (BB 63) and *USS Wisconsin* (BB 64), fired 1,102 16-inch rounds in 83 NGFS missions against targets such as artillery batteries, small boats in port, anti-aircraft sites, bunkers, infantry in trenches, ammunition storage sites, command posts, and tanks. Total ordnance delivered was the equivalent of 542 A-6 missions. Unmanned aerial vehicles (UAVs) were used during most missions for surveillance, targeting, spotting, and battle damage assessment (BDA), and greatly increased the 16-inch gun's effectiveness.

Performance

The 16-inch gun missions can be divided into three categories of targets: BAI into the Kuwaiti Theater of Operations from 4 to 12 February, support of the amphibious raid on the island of Faylakah, and support of ground operations from 20 to 26 February.

Spotting and BDA were provided almost exclusively by UAVs. Two-thirds of the missions received spotting, as well as almost 90 percent of the shells fired, which is a high percentage historically. The battleship fired an average of 19 rounds per mission when spotting was provided. For missions where spotting was not used, three or four shells per mission were fired, mostly for harassment fire against troop and artillery positions.

According to US Navy sources, BDA was obtained in 70 percent (37 of 52) of the missions where spotting was used. Included in the targets reportedly destroyed, neutralized or heavily damaged were three area targets (an artillery/mortar battery and two ammunition/logistic sites) and seven point targets (two surface-to-air missiles or antiaircraft artillery sites, three command/observation posts, a building and a radar/electronic warfare/communication site).

OBSERVATIONS

Accomplishments

- Battleship 16-inch guns and UAVs provided an effective delivery of ordnance against various targets.
- NGFS missions were unaffected by cloud cover or oil field smoke over the targets because the UAVs were able to operate below these conditions.
- The 16-inch guns were reliable and fired all assigned missions without placing aircraft or air crews at risk.

Shortcoming

- The threat of mines kept the battleships from following Coalition ground forces as they advanced rapidly north.

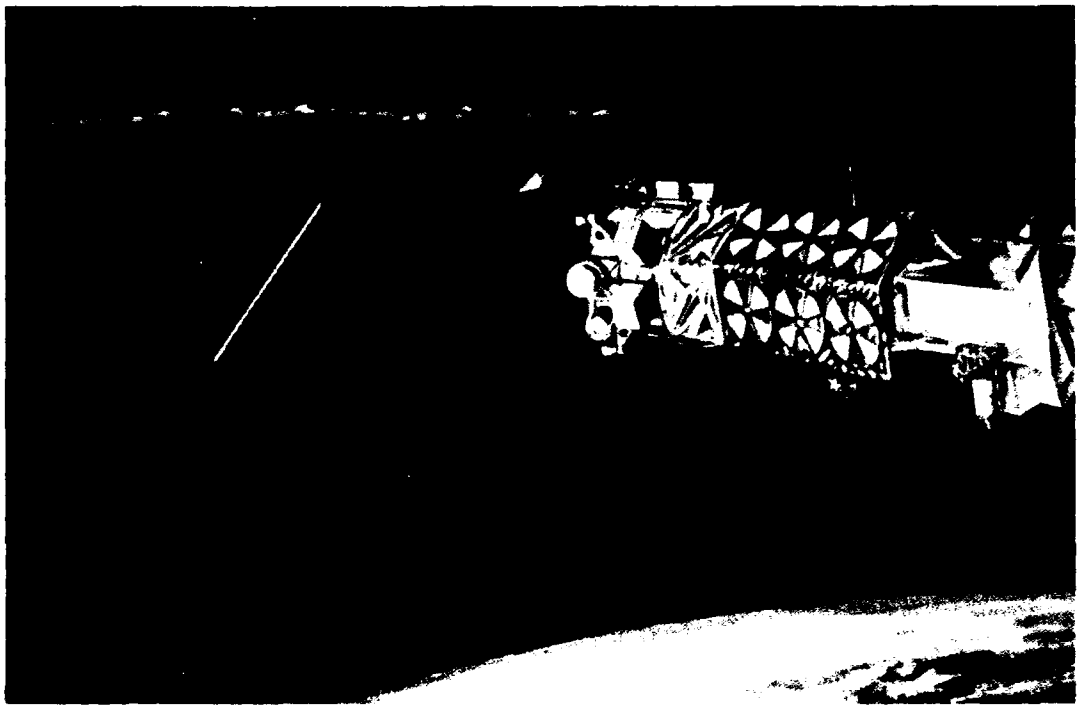
Issue

- *USS Wisconsin* was decommissioned on 30 September, 1991. With the decommissioning of *USS Missouri* in March, 1992, the Navy's existing 5-inch and 76-mm guns provide the only NGFS capability.

APPENDIX T. Performance of Selected Weapon Systems

SPACE SYSTEMS

DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)



Mission

Defense Meteorological Satellite Program (DMSP) satellites provide direct readout of theater cloud conditions to fixed and mobile terminals. The satellite program is designed to collect and disseminate global visible and infrared cloud cover, and other specialized meteorological, oceanographic, and solar geophysical data to support Department of Defense operations and other high priority programs, and tactical field units worldwide.

System Data

Prime Contractor: General Electric
Initial Operational Capability: 1966
Length: 12 ft
Diameter: 4 ft
Weight: 1830 lbs
Orbit: Circular Sun Synchronous Polar
Altitude: 540 miles
Prime Sensor: Optical linescan system
Bands: Visible and IR
Resolution: 0.36 - 1.8 miles

Employment

Three DMSP satellites were available during Operations Desert Shield and Desert Storm. DMSP flights 8 and 9 were available throughout the entire conflict and flight 10 was launched 1 December. Six Mark IV vans (deployable DMSP receiving stations) were deployed. One Air Force (USAF) van was deployed to Riyadh and provided imagery to Central Command (CENTCOM) staff and a Tactical Forecast Unit (TFU). Five Marine (USMC) Mark IV vans were deployed in support of USMC aviation and amphibious operations. Some Navy ships with embarked meteorological personnel (aircraft carriers and aviation-capable amphibious ships) were equipped to receive direct DMSP broadcasts of weather information. Other ships with meteorological personnel relied on civilian weather satellites.

TFU managed Mark IV operations at Riyadh and produced a standard weather report transmitted by high frequency (HF) radio to Army and Air Force (USAF) users in theater. Weather images were faxed from the USAF Mark IV van to USAF units by land lines. Army units received weather images from non-military weather satellites through a commercial receiver which could only receive a civil weather broadcast. The Army chose to use these receivers because the Mark IV van required considerable airlift space (75 percent of a C-141 load) and, therefore, could not meet Army mobility requirements.

Performance

Coalition forces used DMSP and civil weather satellite data to predict rapidly changing weather patterns and to monitor the burning oil wells. Weather information was used extensively to plan and execute attack missions, infer wind direction and potential chemical agent spread, and to alert US forces of sandstorms

or other weather phenomena. This access to current weather data allowed US forces to capitalize on night vision and IR targeting capabilities.

Weather satellites provided key support to US forces in Saudi Arabia and surrounding areas in planning missions, preparing weapons systems, readying defenses, and moving troops. Weather data became especially crucial in the desert where heavy coastal fogs and sandstorms reduced visibility to zero and rains turned desert sands into bogs. Weather data also was used in target selection and in determining the best type of aircraft and munitions to use.

Information on rapidly changing weather patterns was crucial to tactical planners. SWA weather patterns changed within minutes. For example, on 24 January, one DMSP readout showed Baghdad in central Iraq covered by clouds and Basra near the Gulf coast clear. Approximately an hour and a half later, a second DMSP image showed Baghdad clear and Basra overcast.

OBSERVATIONS

Accomplishment

- Weather data was vital to military operations and was widely available to US forces. Both DMSP and non-military satellites played key roles in providing meteorological data on a timely basis. Each provided unique and time crucial data not accessible from another source.

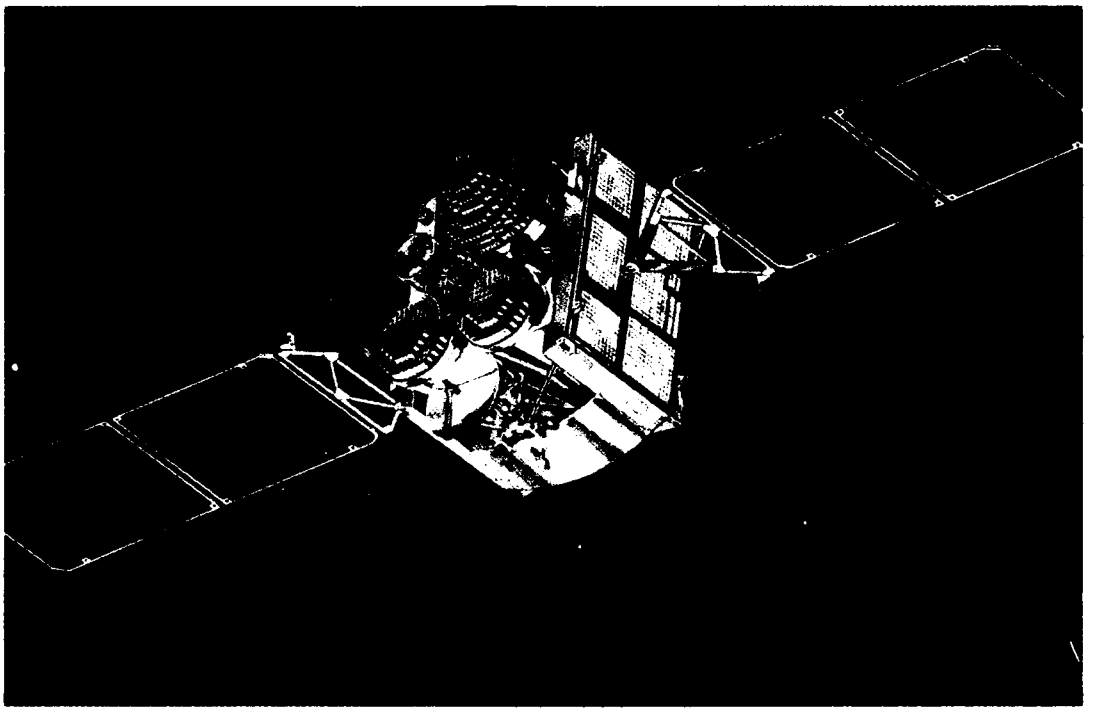
Shortcomings

- Rapidly changing weather patterns in Southwest Asia resulted in tactical units not always having timely and accurate information on target area weather conditions.

- Field units did not have total access to DMSP data. Small tactical DMSP receive terminals will be available for all field units in the next few years.

- Some Navy ships with embarked meteorological personnel did not have access to DMSP data. The required antenna/receiver system has been procured and will be installed as funding permits.

DEFENSE SATELLITE COMMUNICATIONS SYSTEM (DSCS)



Mission

As part of the Defense Communications System, the Defense Satellite Communications System (DSCS) provides communications connectivity for: tactical warning and assessment information transfer; intelligence data transfer to processing segments from remote locations as well as overhead intelligence platforms; missile warning conference; and command and control between the National Command Authorities and deployed military commanders.

System Data

Prime Contractor: TRW/GE (DSCS II and III satellites)
Initial Operational Capability: DSCS II (Nov 71); DSCS III (Oct 82)
Inventory: DSCS II - 4; DSCS III - 4
Satellites: DSCS IIIs
- Three axis, stabilized in geosynchronous orbit
- 10-year design life / seven-year mean-mission life
- Electro-magnetic pulse hardened

Employment

The operational DSCS consists of space, control, and terminal segments. The DSCS Space Segment consists of five operational satellites and three reserves in orbit. These are a mix of DSCS IIs and IIIs over the East Atlantic, West Atlantic, East Pacific, West Pacific, and Indian Ocean. Two additional DSCS IIs have severely limited capability and a DSCS III, launched in 1982, which is severely degraded, provide the reserve satellite support in orbit.

The DSCS II satellites, developed in the late 1960s, have no unique military features to sustain operations in hostile environments, such as jamming and nuclear scintillation. The DSCS III satellites were developed in the late 1970s and incorporated unique military features to make them jam resistant and nuclear hardened.

The DSCS strategic terminal segment has a range of antennae from large fixed terminals with 60-foot parabolic antennas to 30-inch antennae supporting users such as the National Emergency Airborne Command Post. Ground Mobile Forces (GMF) terminals equipped with eight and 20-foot antennas and the Navy shipboard terminals equipped with four-foot antennae support the DSCS tactical user requirements.

The DSCS requires users to share power and bandwidth of an individual transponder channel. As a result, discipline is imposed on all user terminals to assure they conform to their specific frequency and power assignment. Should a user terminal vary from its assigned parameters, it will adversely affect other users and possibly could disrupt the entire satellite channel and eliminate space segment access for hundreds of users. Network control is performed through the DSCS Operations Centers (DSCSOCs), located with large fixed DSCS ground terminals. These DSCSOCs have direct connectivity to all user terminals in their area of control to assure continuous operation and support resolution of terminal problems when the terminal operators can not resolve them. The tactical users, such as GMF and the Navy, are sub-networks operated within assigned allocation.

Performance

DSCS played a major role in providing command, control and intelligence information during Operations Desert Shield and Desert Storm. Before the invasion of Kuwait, there were only four tactical DSCS terminals in the area of responsibility (AOR). By 5 January, more than 120 tactical DSCS terminals had been deployed to serve in major support roles, providing communications for combat, combat support and service support operations. The Joint Forces Air Component Commander used DSCS daily to transmit the air tasking order to air bases. DSCS supported a 75 percent increase in intelligence relay to the continental United States for processing and return to the theater. Tactical GMF terminals moved with offensive forces as they deployed to the West for a flank attack. Antennae were loaded on flatbed vehicles to avoid disassembly. As forces made intermediary stops, connectivity to higher command headquarters was established immediately using the DSCS satellite. By the end of the war, 33 GMF tactical terminals were supporting combat forces in Kuwait and Iraq, providing command, control, and intelligence communications.

OBSERVATIONS

Accomplishments

- The DSCS was the principal multi-channel transmission system for intra- and inter-theater communications during the early phase of Operation Desert Shield. DSCS initially provided 75 percent of all inter-theater connectivity and was used extensively to support intra-theater requirements covering deployment of forces across long distances not supportable by terrestrial systems.

- Commercial augmentation of satellite communications also proved helpful.

Shortcomings

- Satellite communications were vulnerable to jamming and spoofing.

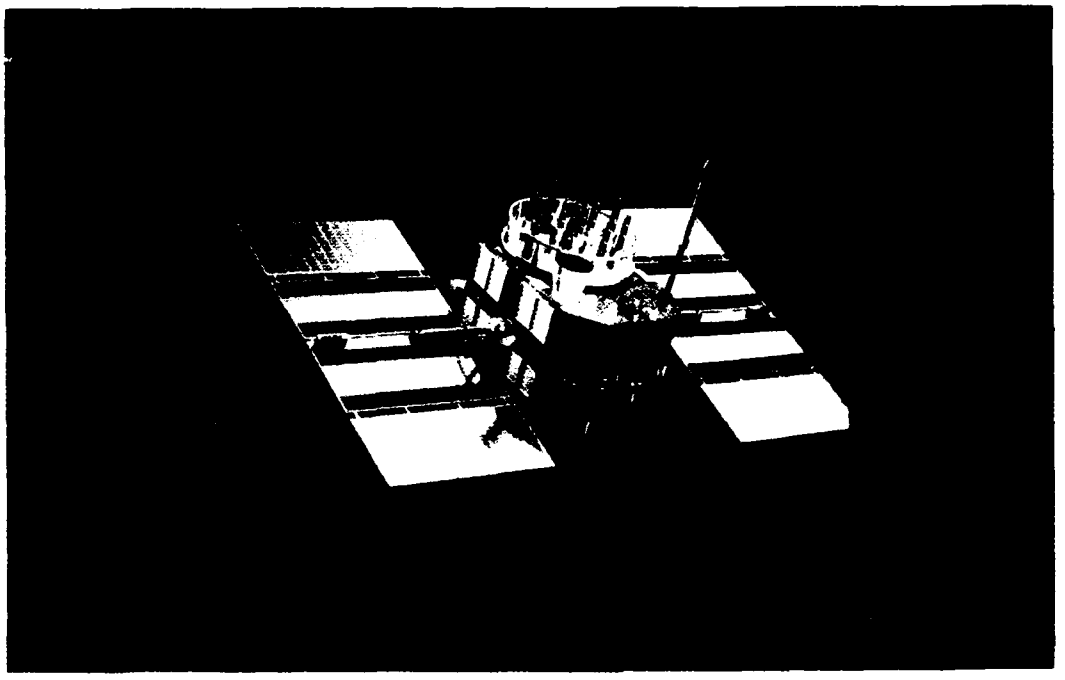
- The overall satellite constellation lacks redundancy and there is no capability to launch replacement satellites quickly.

- Some older ground segment terminal equipment requires extensive maintenance.

Issue

- Current DSCS fixed ground terminal equipment is 1970s technology and has exceeded its life-cycle. Components and repair parts no longer are manufactured. The heavy terminal/medium terminal (HT/MT) part of the DSCS program provides for modernizing the terminal with state-of-the-art technology, extending the life cycle another 15 years and reducing operating and support costs. Funds are programmed with contract award scheduled for early FY 92 and modernization to start in FY 94.

GLOBAL POSITIONING SYSTEM (GPS)
NAVSTAR-GPS



Mission

Global Positioning System (GPS) is a satellite based, radio-navigation system that provides precise, world wide, three-dimensional position, velocity, and timing data. NAVSTAR-GPS satellites operate in inclined, semi-synchronous, 12- hour orbits. When GPS is fully operational in 1993, it will consist of a constellation of satellites that will provide continuous three-dimensional, worldwide coverage. During the Persian Gulf War, 16 GPS satellites provided navigation and positioning data. When the constellation is fully deployed, there will be 24 satellites (21 primary systems and three spares).

System Data

Prime Contractor: Rockwell International
Projected Full Operational Capability: 1993
Size: 5 feet x 17 ft 6 in
Weight: 2,000 pounds (on orbit)
Launcher: DELTA II ELV with PAM-D upper stage
Orbit: Circular, 55 degree inclination
Altitude: 13,000 miles; Orbital Period: 11.996 solar hours
Design Life: 7.5 years
Constellation: Six planes, four satellites per plane
Control segment: Master Control Station (MCS), Falcon Air Force Base, CO
Monitor Stations: Hawaii, Colorado Springs, Ascension Island, Diego Garcia, Kwajalein Island
Ground (control) Antennas: Ascension, Diego Garcia, Kwajalein

Employment

Navigation in a featureless desert posed significant challenges. There were almost no man-made or natural features to confirm positions. A precise navigation means was required to aid combat forces. GPS met this need.

GPS receivers were used throughout the theater to assist forces at sea, on land, and in the air. For example, GPS fixed navigational positions during mine clearing operations and provided launch coordinates for ships firing TLAM. Among other uses, GPS guided maneuver units, helped minimize fratricide, registered artillery and precisely located land mines. The Air Force used GPS to guide aircraft to targets.

Because of the immediate need for GPS receivers, Coalition forces relied on commercial GPS receivers. Almost 85 percent of the receivers US forces used were commercial, non-crypto capable models. The lack of secure GPS receivers meant that, had the enemy the capability to do so, he might have benefited from the system also. By March, 4,490 commercial and 842 military GPS receivers had been deployed.

Performance

The GPS constellation was improved to support US forces in the operating area by changing the launch plane of a GPS satellite launched in October. There was adequate two-dimensional coverage (latitude and longitude) for almost the entire

day and three dimensional (latitude, longitude, and altitude) coverage for about 19 hours a day. (By comparison, troops at Fort Bragg, NC, could receive good 3-D coverage for about 15 hours a day.)

The heavy reliance on commercial receivers forced the US to keep Selective Availability (SA) off. SA is the intentional corruption/degradation of positioning and timing data so that non-military users do not receive military data. Throughout the war, commercial and military versions of the GPS receivers displayed comparable accuracies. The military receiver provided about 16 meters spherical error probable accuracy, while the commercial small, lightweight receiver (SLGR) provided about 25 meters accuracy. This variation in accuracy often is caused by satellite geometry and user dynamics. If SA is employed, the commercial SLGR gives a much less accurate position.

OBSERVATIONS

Accomplishments

- GPS was used more extensively than planned and met navigation and positioning requirements.
- The GPS satellite constellation was optimized for use in the AOR.

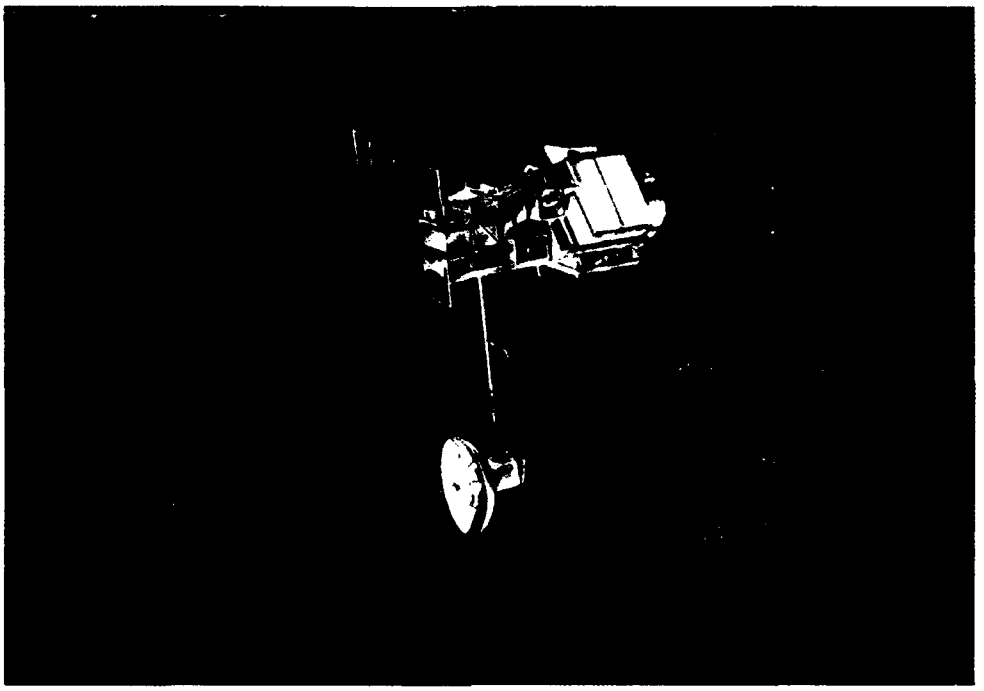
Shortcomings

- There were not enough military versions of the GPS receiver available, which led to the off-the-self purchase of thousands of commercial, non-SA receivers. The reliance on commercial receivers required keeping SA off.
- The United States shipped as many receivers as possible for more than six months, but was still unable to satisfy unit demand.

Issues

- The GPS Joint Program Office is procuring a military version of the small lightweight receiver which will be available in 1994.
- GPS should be considered for incorporation into all weapon systems and platforms.

MULTI-SPECTRAL IMAGERY: LANDSAT



Mission

LANDSAT provides multi-spectral surface imaging for geological and ecological mapping and surface-change detection. LANDSAT is designed and used for civil and commercial peacetime uses. However, military applications inherent in the remote sensing capabilities of multi-spectral imagery (MSI) have been developed and are being expanded. In addition to LANDSAT, the French SPOT – Satellite Probatoire d'Observation de la Terre (Exploratory Satellite for Earth Observation) also provides MSI data. The former Soviet Union's (Meteor Prioida) and Japanese (MOS-1) also have MSI systems.

LANDSAT is managed by the Department of Commerce, National Oceanographic and Atmospheric Administration. It is operated by Earth Observation Satellite Corp., a contractor.

System Data

Orbital parameters: 98.2° Inclination, 438-mile altitude.
Weight: 4,270 lbs
Initial Operational Capability: LANDSAT-5 launched in 1984, originally had been expected to operate only until early 1989
Thematic mapper: Seven-band scanning radiometer. Operates from 0.45 to 2.35 microns. Resolution: 98 ft
Four band scanning radiometer: Operates from 0.5 to 1.1 microns, resolution , 262 ft
Thermal infrared band: Single band. Operates from 10.4 to 12.5 microns, resolution, 394 ft
Scene size: 185 km by 170 km

Employment

MSI provided direct war-fighting support during Operation Desert Storm. Because of MSI's unique nature, military planners were able to obtain information normally not available. Furthermore, MSI showed features of the earth beyond human visual detection capability.

Performance

When US forces deployed to Southwest Asia, many maps of Kuwait, Iraq, and Saudi Arabia available to US forces were 10 to 30 years old. To correct this deficiency, MSI satellite systems were used to image the theater; the Defense Mapping Agency (DMA) prepared new maps based on these images. Since MSI maps are images of the earth, they show existing roads, trails, airfields, etc. Clear, open areas, which may be suitable for military purposes, also stand out and are easily factored into planning. For example, after the 82nd Airborne Division obtained a LANDSAT map of Kuwait City, it asked for national imagery to determine if there were traps or obstructions that would prevent an airborne landing. MSI images may be able to show subsurface features down to 30 meters, depending on water clarity. The Navy used MSI data in planning amphibious operations during Operations Desert Shield and Desert Storm.

OBSERVATIONS

Accomplishments

- MSI data was used to plan military operations, and to train and prepare for strike operations.
- MSI data provided unique information on Iraq's order of battle.

Shortcoming

- Current LANDSAT images give 30-meter resolution. The French SPOT system gives 10-meter resolution (black and white image); the Russians advertised five meter resolution. Although the LANDSAT system provides a crucial capability and is still competitive, it is limited in responsiveness, stereoscopic imaging, and resolution.

Issue

- The future of the LANDSAT MSI system is now being determined. A Mission Need Statement (MNS) for remote earth sensing has been validated by the Joint Requirements Oversight Council. This MNS addresses MSI as well as other remote earth sensing requirements.